CRM 95-214 / March 1996

People's War at Sea: Chinese Naval Power in the Twenty-First Century

Christopher D. Yung

Center for Naval Analyses
4401 Ford Avenue • Alexandria, Virginia 22302-1498

Approved for distribution:

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Jerome H. Kahan, Director
Regional Issues Team
Policy, Strategy, and Forces Division

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Summary

The Commander, Seventh Fleet, asked CNA to assess the security environment of the Asia-Pacific Region (APR) to the year 2010. In addition to an examination of the major countries of the region, of security trends in Asia (e.g., demographics and weapon development), and of future economic trends in the APR, this assessment warranted an evaluation of Chinese naval capabilities over the period of interest. This research memorandum presents the results of that evaluation. The overall findings of this research effort are in the project's final report, *The Dynamics of Security in the Asia-Pacific Region* (CNA Research Memorandum 95-172, January 1996).

Much of the debate over China's future naval capabilities focuses on whether China will soon have a "blue water" navy. We define "blue water" here as the capability to seriously contest control over the seas adjacent to the Chinese coasts—the South China Sea and the East China Sea—as well as the capacity to simultaneously threaten to deny access to the Sea of Japan, the Philippine Sea, and the Northern Pacific Ocean against any other navy, excluding the USN.

In this analysis, we argue that one of China's strategic objectives is to develop a regional navy. We define "regional" or "green water" navy as a navy capable of effectively achieving China's current regional aspirations (e.g., blockade of Taiwan, seizure of one or more islands in the Spratlys, sustainment of a naval force in the South China Sea, and the ability to inflict damage upon an intervening foreign navy).

Approach

For China to develop a modern, regional navy, it would have to: (1) build itself such a fleet, (2) buy such a navy or components of such a navy entirely from other countries, or (3) import a small number of advanced weapons and platforms, take them apart, do some reverse engineering on these sample systems, and mass produce them. In

assessing China's capacity to build itself a modern fleet by 2010, we examined its current defense industry, its state of education, and its history of weapon and military hardware production. We projected China's future defense expenditures (depending on different assumptions of China's economic performance) and the cost of weapon systems in order to assess China's capacity to buy a modern fleet by 2010. Finally, we examined China's record of reverse engineering in producing advanced weapon systems and platforms and whether, through that process, China could build itself a modern fleet by 2010.

Findings

Building a navy

China cannot develop and build a regional navy before 2010 on its own. Its defense industry currently produces weapons and platforms that are decades behind those of the United States and the developed countries of the West. Furthermore, China lacks the pool of educated individuals necessary for such an endeavor.

Buying a navy

If China cannot build a modern, region-oriented navy, it could attempt to purchase such a navy by 2010. This approach, however, would be very expensive and would depend on China's future economic performance:

- *Optimistic assumptions.* Assuming China's annual GDP grows 8 percent for 15 years, and assuming that China would be willing to purchase a regional navy off the shelf, the Asia-Pacific Region could, by 2010, be confronted with a Chinese navy that included several attack submarines, two large-deck aircraft carriers, a VSTOL carrier, Aegis cruiser equivalents, a sizable number of frigates and destroyers, and a significant force of underway-replenishment ships. This conclusion also assumes that China chooses to make these investments at the expense of other civil or military programs.

- *Moderate assumptions.* Assuming China's annual GDP grows at 4 percent for 15 years, the region could face by 2010 a Chinese navy that included two small VSTOL aircraft carriers; a small number of Aegis cruiser equivalents; a medium-size submarine, destroyer, and frigate fleet; and a small number of supply ships. Again, this assumes that China wishes to invest its resources for this purpose.

- *Pessimistic assumptions.* Assuming China's economy stagnates at zero-percent annual GDP growth for 15 years, the region could face, by 2010, only a coastal Chinese navy.

Even with an annual GDP growth rate of 8 percent, the navy that China could purchase by 2010 should not be considered a "blue water" force as we define it, but a "green water" or regional naval force. In any case, China would be reluctant to purchase a regional navy off the shelf. This approach would: (1) place Chinese national security in the hands of other countries and foreign defense manufacturers; (2) alarm China's neighbors and put at risk a stable political and security environment for China's economy to thrive in; and (3) deprive Chinese engineers and industry of the opportunity to develop China's military force and economy through reverse engineering.

Reverse engineering a navy

This process involves importing a small number of sample advanced weapons or platforms, taking the systems apart to determine how they work, developing design specifications for a prototype model, constructing the equipment and physical plant to produce this model, training the technicians, testing and evaluating the prototype, and then mass producing the system.

China would find it difficult to reverse engineer a regional navy by the year 2010, however, because the Chinese defense industry has historically taken about 15 years to reverse engineer a weapon system or platform from the moment sample systems were purchased to the initiation of series production. Substantially more time would then be needed to produce a usable fleet. In addition, to reverse engineer such a navy by 2010, China would require an initial outlay of funds for

sample systems that exceeds its willingness and capability to spend on defense.

On the other hand, China could successfully reverse engineer a regional naval force if it extended the time required to complete the process to a target date after 2010 (probably to around 2020) and, again, chose to maximize its resources for that purpose. China could then afford and be willing to purchase the sample weapon systems and platforms for a process stretched out over a longer period of time. Once systems were designed and production lines established, there would be time and resources to produce a fleet. A gradual process of reverse engineering and defense modernization would avoid alarming China's neighbors and promote a peaceful region in which China's overall economic modernization can take place.

Implications and recommendations

The above findings suggest that:

- Assumptions that China will deploy a capable naval force that potentially challenges the U.S. Seventh Fleet by 2010 exaggerate China's capabilities. Defense planning projections that indicate a regionally oriented Chinese navy by about 2020 are more accurate.
- Planning against and tracking a future Chinese regional navy may be good long-term insurance, but sizing today's forces for an up-and-coming Chinese naval threat by the first decade of the 21st century would be premature.
- If Chinese economic growth continues at historically high levels (8 percent) and Chinese forces are seen to develop at corresponding rates, it becomes useful to consider taking concrete steps to hedge against a possible People's Liberation Army Navy threat by around 2020.

Introduction

This section provides some background information on China as a potential threat to Asia and an overview of the issues involved in assessing China's future naval capabilities. It also outlines the contents of the rest of this paper.

China as a threat to Asia

Some analysts have predicted that by the first decade of the 21st century, China will have a limited blue-water capability and enough naval force to threaten the South China Sea, Taiwan, and perhaps Japan. Those analysts have predicted that China's acquisition of Su-27 fighter aircraft from Russia and of in-flight refueling kits from Iran, combined with the PLA Navy's (PLAN's) efforts to enhance blue-water capabilities by retrofitting vessels with propulsion and weapon systems purchased from the industrial democracies, will enable China to conduct offensive operations in the South China Sea.[1] Other China watchers have argued that "the combination of technological improvements now under way in the Chinese military and the construction of air and naval bases on Chinese-occupied islands will soon give China the ability to restrict the flow of shipping through the South China Sea—in effect, to cut Japan's jugular vein."[2] Finally, there is the view that China will become a serious security threat to the region because the Chinese navy

> ....expect[s] to overwhelm [its] regional opponents with technologically superior weapons in a war of rapid movement. Air superiority and ground attack aircraft purchased

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1. A. James Gregor, "China's Shadow Over Southeast Asia," in *Global Affairs*, Summer 1992, pp. 7-8.

2. Denny Roy, "Hegemon on the Horizon?" *International Security*, Vol. 19, No. 1, Summer 1994, p. 164.

> from Russia, with ranges extended by in-flight refueling, would be committed to assure tactical air superiority. Frigates and destroyers, with sensor and fire-control capabilities, enhanced by systems purchased from Western vendors, possibly in a task force built around a light aircraft carrier, would provide perimeter defense and offshore support for any assault on disputed territory in the Taiwan Strait or the South China Sea.[3]

Fear of an expanding military and naval capability are not confined to U.S. academics and defense analysts. Government officials of the countries of Asia are concerned, if not alarmed, as well. On May 13, 1995, Singapore Prime Minister Goh Chok Tong, while in Beijing, said that "China's arms build-up and its assertive policy on the Spratly Islands has triggered suspicions and fear..."[4] Philippine President Fidel Ramos said at a Philippine National Security Council meeting that China's military clash with the Philippines over Mischief Reef in the disputed Spratly Islands was part of a long-term goal of expanding claims in the South China Sea. He compared China's "step by step movement" in the Spratlys to its actions in the 1970s when it took over the Paracels Island Group from Vietnam.[5] Prime Minister Tomiichi Murayama of Japan expressed concern over Chinese actions in the South China Sea when he spoke with Chinese Premier Li Peng at a United Nations conference in Copenhagen.[6] Finally, Asian academics and defense scholars appear to reflect the concern of their government officials that China's growing economic might and its improving naval and military capabilities *could* prove destabilizing and

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3. James B. Linder. "Chinese Military Strategy," in *Global Affairs*, Winter 1993, p. 70.
4. "China Warned Over Spratlys," *The Asian Defense Journal*, July 1995, p. 68.
5. Shalan Devi, "On China's Moves," *The Asian Defense Journal*, June 1995, p. 69.
6. Shalan Devi, "Philippines: On Armaments and the Spratlys," *The Asian Defense Journal*, May 1995, p. 75.

threatening in Asia. The views of several of these academics were evident at numerous workshops and conferences.[7]

Chinese naval power in the 21st century

For China to possess a regional navy, it must do at least one of the following: (1) build a regional naval capability; (2) import Western technology, reverse engineer that technology, and mass produce platforms and weapon systems for a region-oriented navy from that technology; (3) buy all the assets it needs for a regional naval capability.

China's economy has enjoyed an average of about 9-percent growth since the late 1970s, and has experienced 12- to 13-percent growth since 1989. Fifteen years ago, few observers would have predicted that by 1995 China would have the third largest economy in the world or that its exports would ever exceed U.S. $170 billion a year.

The Chinese have shown that they are capable of "borrowing" foreign technology and using it to mass produce some military assets. They successfully reverse engineered the Russian MiG-19, eventually mass produced the F-6 attack aircraft, and conducted some other relatively successful efforts at reverse engineering over the past 40 years.

The People's Republic of China also appears to have funds to buy advanced weapon systems and platforms. China has recently purchased aircraft (the Su-27 Flanker attack aircraft) and technical assistance from Russia at an estimated cost of U.S. $1.5 billion. It is possible that over the next 10 to 15 years, the PLAN will buy the inventory for a regional navy.

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7. For example, see the views of Korean defense analysts in Sung Hwan Wie, Chang Su Kim, Perry Wood, David Carlson, and Christopher Yung, *Prospects for U.S.-Korean Naval Relations in the Twenty-First Century,* Rapporteurs' Report for the CNA-KIDA Conference, February 1995, p. 6. Also see the views of Asian scholars as expressed in Paul Kreisberg, Daniel Chiu, and Jerome Kahan, *Threat Perceptions in Asia and the Role of the Major Powers: A Workshop Report,* Center for Naval Analyses/East-West Center, February 1993, pp. 14-15.

Although it is possible that China will be able to build, reverse engineer, or buy the military equipment for a regional navy, analyses of such prospects need to consider the problems and constraints that would make it difficult for China to do so. Can China buy a regional naval capability if its economic growth slows to virtually nothing and the cost of imported aircraft is experiencing 12-percent inflation? Could Chinese industry build and maintain a regional navy if China no longer had access to foreign technology and assistance? What constraints and problems have plagued China's past efforts to reverse engineer Western technologies? Do these constraints and problems suggest a relatively quick turn-around time (i.e., ten years or less) for Chinese industry to import technology, reverse engineer that technology, and mass produce weapons and platforms using that technology?

Finally, any discussion of China's future naval capability requires a clarification of terms used to describe the Chinese navy. The argument that China may soon have the air, naval, and marine forces to seize one or many islands in the Spratlys, to sustain a naval force in the South China Sea for a prolonged period of time against intervening naval forces, and to blockade or invade Taiwan (i.e., all of China's grand strategic objectives) is used repeatedly to represent the view that China may soon have a blue-water navy. For the purposes of this paper, we argue that, for the Chinese navy to be considered a blue-water navy, it should be able to seriously contest control over the seas adjacent to the mainland's coasts (the South China Sea and the East China Sea) and to threaten to deny those sea lanes giving access to Chinese coasts (the Sea of Japan, the Philippine Sea, and parts of the North Pacific Ocean) against any other navy, excluding the USN. "Green-water navy" may be a better term to describe a Chinese navy that can operate beyond China's immediate coasts, achieve some limited (but important) strategic objectives at a distance from China, and possibly inflict damage on intervening navies and air forces.[8] Because such a navy can influence events region-wide in Asia, we will refer to it as a green-water or regional navy.

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8. The author thanks Professor Paul Godwin of the National War College for this helpful insight.

Approach

Before we can assess China's likely naval capabilities in 2010, we must first look at China's current naval capabilities. The next section of this memorandum discusses the PLAN's order of battle and assesses its current military effectiveness.

The following section of the memorandum assesses whether China's defense industry is capable of building a modern navy by 2010. It does so by examining the educational level of China's current population, the status of China's current defense industry and those platforms and weapons that the Chinese defense industry now produces, and the perspectives of some of the countries purchasing military items from China.

We then use methods developed at CNA to address the question of China's ability to buy itself a modern navy. CNA's Economically Feasible Threat Model projects possible future defense budgets for a typical Third World country and compares those budgets (broken down by procurement of aircraft, ships, and weapons) to projected unit costs of specific types of platforms (e.g., ships and aircraft). When applied to China, the model illustrates what naval force structure the PLAN can afford to buy given a zero-percent, 4-percent, or 8-percent rate of GDP growth.

The next-to-last section of the main text examines China's defense industry's record of reverse engineering advanced platforms and weapons. As a guide to how long it would take China's industry today to reverse engineer the inventory for a regional navy, we use the average length of time China's defense industries have required over the past 40 years to import platforms and weapons, reverse engineer those items, and produce them in a series. To determine whether the Chinese can afford to reverse engineer and mass produce a regional fleet, we assess the cost to China to purchase the small number of sample assets it needs to reverse engineer a modern navy by 2010 and match that cost to an estimate of China's current and projected budgets for the procurement of weapons and platforms.We then examine whether it is more affordable for the Chinese to buy the high-priced items necessary to begin the reverse engineering process and whether

successful reverse engineering efforts are more likely if the process is stretched out to a time period beyond 2010—perhaps to 2020.

The final section of the main text presents our conclusions, discusses the implications of the findings for the United States Navy and for Seventh Fleet, and makes policy recommendations.

Four appendixes follow that address: (1) the methodology for calculating future defense budgets and costs of military assets, (2) calculations of the cost and affordability of Chinese reverse engineering plans, (3) anticipated objections to the analysis and other issues addressed, and (4) sources of information on Chinese reverse engineering efforts.

This memorandum focuses on the questions of whether China can build a navy, buy a navy, or, through reverse engineering, find a way to produce its own weapons and platforms. Our analysis does *not* address additional capability-related questions such as whether and how the trained personnel to man this force, and the logistics and maintenance support, would be acquired.

Current PLA naval capabilities

The People's Liberation Army Navy came from humble beginnings. Before the Communist takeover of mainland China, the PLA Navy was made up mostly of junks, a few frigates captured from the Nationalists, and riverine craft. By the time the Communists took over mainland China in 1949, the PLAN comprised mostly "former U.S. craft, especially amphibious landing vessels"[9] after the PLA expelled the Nationalists (KuoMinTang or KMT) from the mainland and took over those few vessels that the KMT had in its possession.[10] In July 1949, however, Mao endorsed the modernization of the PLA Navy because he was concerned with the security implications of the following: (1) the Nationalists still controlled many offshore islands—islands within artillery range of mainland China, (2) the KMT Navy controlled mainland SLOCs from the city of Shanghai to its south, and (3) the USN could mount amphibious attacks against China's coasts.[11]

By the 1950s, with Soviet assistance, China was able to develop the infrastructure for a navy. The Soviets provided technical assistance for the construction of Soviet-designed submarines (Whiskey class) and frigates (Riga class), and even provided the components for construction.[12] The Chinese were also able to develop a naval air arm and an

9. John Jordan, "The People's Liberation Army Navy (PLAN)," *Jane's Intelligence Review*, June 1994, p. 275. See also Bruce Swanson, *Eighth Voyage of the Dragon: A History of China's Quest for Seapower*, Naval Institute Press, Annapolis, MD, 1986.

10. Jordan, p. 275.

11. Swanson, pp. 183-5.

12. Jordan, p. 275; and Swanson.

air force through Soviet technical assistance and acquisition of MiG-17/19s and Il-28 jet bombers.[13] China's naval modernization efforts went so far as to begin the development of a strategic missile submarine program (SSBN), again with Soviet assistance.[14] Soviet assistance for this program, however, as well as the overall technical assistance for military modernization, ground to a halt with the Sino-Soviet split of the early 1960s.[15]

China's naval and military modernization efforts on the whole suffered during the mid 1960s to the mid 1970s when radical, Leftist policies dominated Chinese politics during the Great Proletarian Cultural Revolution (Wujie Wenhua Da Geming). These efforts were revived, however, with the return to power of Deng Xiaoping and his colleagues and their concern with modernization in order to meet the Soviet threat. The PLA's interest in modernizing was reinforced in the wake of the PLA's disastrous invasion of Vietnam in 1979. It was doubly reinforced as the Chinese navy assessed the difficulty of patrolling and defending China's large Exclusive Economic Zones (EEZs) and maritime territories, and as the PLA witnessed the performance of a modern military force during the Falkland and Desert Storm campaigns.

China's naval forces today

Over the past decade, the PLAN has increased in size and effectiveness. China has more than doubled its replenishment ship fleet, acquired destroyers and frigates with greater range and speed, upgraded its submarine fleet through the purchase of Russian Kilo attack submarines, and developed a new and quieter class of attack

13. Jordan, p. 275; and Kenneth Allen, Glenn Krumel, and Jonathan Pollack, *China's Air Force Enters the Twenty -First Century,* RAND, Santa Monica, CA, 1995, pp. 35-69.

14. John Lewis and Xue Litai, *China's Strategic Seapower: the Politics of Force Modernization in the Nuclear Age,* Stanford University Press, Stanford, CA, 1994.

15. Ibid; and Jordan, p. 275.

submarine—the Song class. Table 1 shows the PLA Navy order of battle.

Table 1. People's Liberation Army (Navy) order of battle

Platform type	1985-86	1989-90	1995-96
Missile submarines (SSBN, SSB)	3	2	1
Fleet submarine (SSN)	3	2	5
Patrol submarines	104	48	70+
Cruise missile submarine	-	1	1
Destroyers (DD)	19	18	17
Frigates	30	33	35
Fast attack craft (missile, gun, torpedo, patrol)	827+	801+	410
Coastal patrol craft	9	6+	26
Minesweepers (ocean)	24	32	27
Mine warfare craft	80+	50+	·5
LSTs (Amphib)	22	16	18
LSMs (Amphib)	24	46	32
LSILs (Amphib)	6	4	-
LCTs (Amphib)	10	-	-
LCMs-LCUs	520	420+	403
Troop transports	-	9	9
Supply ships	25	29+	21+
Tankers (large and small)	36	29+	87

Source: *Jane's Fighting Ships, 1985-6, 1989-90, and 1995-6*, pp. 94, 100, and 114, respectively; *Combat Fleets*, 1995, and *Combat Fleets*, 1988-89.

Over the past five years, China has also embarked on a naval replacement shipbuilding program. This program has focused on developing destroyers and frigates, ASW capability, ship defenses, medium-lift amphibious ships, resupply ships, and a continuing emphasis on coastal patrol craft. (See table 2 for a list of China's naval construction projects 1990-1995.) China has not emphasized development of either aircraft carriers or sea lift capable of carrying large numbers of troops.

China's purchase of a small number of French Crotale point defense surface-to-air missiles has increased the PLAN's capabilities to

Table 2. Chinese modern naval shipbuilding efforts, 1990-1995

Ship class	Type of ship	Mission	Unclassified source
Luhu	Destroyer	ASW, ASUW, ship defense	*Jane's Defence Weekly,* 18 January 1992, p. 88-9
Luda III	Destroyer	ASW, ASUW, ship defense	Ibid.
Jiangwei	Frigate	ASW, ASUW, ship defense	Ibid.
Jianghu III	Frigate	ASW, ASUW, ship defense	Ibid.
Huang	Fast attack craft	Coastal patrol	Ibid.
Houxin	Fast attack craft	Coastal patrol	Ibid.
Xiang Yang Hong 09	AGI electronic monitoring ship	Seaborne intelligence gathering	Ibid.
Dadie class	AGI electronic monitoring ship	Seaborne intelligence gathering	Ibid.
Dayun class	Resupply vessel	Sustainment	*Jane's Defence Weekly,* 19 February 1994, p. 27.
Yukan class	LST, tank landing ship	Amphibious ship	*Asian Defence Journal*, May 1994, p. 30.

provide air defense for its surface ships. The PLAN has also improved the ASW and AAW capabilities of its destroyers. Some have been fitted with Crotale surface-to-air missile launchers, a Dauphin helicopter, the FQF-2500 ASW rocket system, and eight C-801 surface-to-surface missiles.[16] Furthermore, China has tried to improve its air-to-air refueling capabilities by building in-flight refueling kits and has recently

16. See Stephen L. Ryan, "The PLA Navy's Search for Blue Water Capability," in *Asian Defence Journal*, 5/94, p. 28. For other examples of Chinese surface ship improvements, see "New Ships for the PLAN" in *Jane's Defence Weekly*, 18 January 1992, p. 88. Also Gordon Jacobs, "Chinese Naval Developments Post-Gulf War," in *Jane's Intelligence Review*, February 1993, p. 83.

purchased Russian Su-27 fighters.[17] In addition, there are unclassified reports that the Chinese still want to enter into a joint venture with Russian technicians to assemble MiG-31s.[18]

China has created a Marine Corps and has deployed part of this force on bases in the South China Sea and on Hainan Island opposite the Spratly Islands.[19] By purchasing ten Russian Ilyushin Il-76 heavy transport aircraft and by restructuring the PLA's airborne forces from brigades to divisions, China has improved its airborne assault potential.[20] China has also procured more medium-size amphibious lift, as shown by the increasing number of LSTs and LSMs in its

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17. The Su-27's primary purpose is as a tactical fighter to seize and maintain air superiority over a theater of interest, but it can also be used in a ground attack role. This aircraft represents by far the best fighter capability the PLA Air Force (PLAAF) has ever possessed. See *Jane's All the World's Aircraft, 1994-5*, pp. 359-60. Also see Edmond Dantes, "The PLA Air Force Build-Up: An Appraisal," in *Asian Defence Journal*, 11/92, p. 43.

18. Dantes, p. 43.

19. The PLA has about 6,000 Marines. See *Periscope Chinese Navy/Marine Corps Data Base* by United Communications Group in Cooperation with the U.S. Naval Institute, Copyright July 1995. See Paul H. B. Godwin, "Chinese Military Strategy Revised: Local and Limited War," *The Annals of the American Academy of Political and Social Science*, 519 (January 1992), p. 196. Also see A. James Gregor, "China's Shadow Over Southeast Asian Waters," in *Global Affairs*, Summer 1992, p. 3.

20. Three brigades of the 15th Group Army (Airborne) based in Taiyuan have been redesignated, in anticipation of future increase in size to divisions. Chinese brigades have about 3,000 to 4,000 troops, while divisions normally have about 15,000 troops. See "PLA Airborne Brigades Become Divisions" in *Jane's Defence Weekly*, 2 October 1993, p. 12. Also see "Chasing the 20th Century: Country Briefing, China," *Jane's Defence Weekly*, 19 February 1994, p. 27.

inventory.[21] The PLA high command has also openly discussed the possibility of acquiring aircraft carriers in the future.

The limits of China's naval forces

Changes in inventory and organization do not immediately become improvements in actual capability. The PLAN still suffers from a number of shortcomings. Despite efforts to improve China's fleet air defense with imports such as the French Crotale surface-to-air missile, only a few of China's surface ships have them. Furthermore, China's surface ships armed with the Crotale (which has a range of 7 n.mi.), would be ineffective against aircraft firing missiles such as the Harpoon or the Exocet, which have a 50-to-100-mile range.[22]

In an environment in which the PLAN's ships are vulnerable to air-launched antiship missiles, the PLAN and the PLAAF would have to provide the fleet with excellent air cover. Here too, China's navy and air force prove inadequate. At present the PLA lacks the aircraft with the range, speed, and maneuverability to provide adequate air cover for a PLAN task force heading toward the Spratlys or Taiwan.

The recent acquisition of the Soviet Su-27 (Flankers)should help the PLAN improve its short-range air cover.[23] However, even with in-flight refueling capability (which the Chinese do not have much of), the 26 Su-27 Flankers would not be able to provide more than a "very small

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21. Chinese amphibious lift capabilities should not be exaggerated.Using all the amphibious lift assets available to the Chinese (including the PLAN's Qionsha, Shan, Yukan, Yuliang, Yudao, Yunnan, and Yuch'in class vessels), the Chinese would be barely able to transport the ascribed personnel of one Chinese division by sea. They would not, at the same time, have space for initial landing of heavy equipment or consumables. This also assumes that these amphibious assets would be available again after offloading ground troops. Most of the Chinese amphibious warfare vessels can carry about 200 troops (some can carry up to 400 troops). For more details see *Jane's Fighting Ships, 1995-6*, pp. 131-2.
22. Michael G. Gallagher, "China's Illusory Threat," in *International Security*, Vol. 19, No. 1 (Summer 1994), p. 179.
23. Ibid. p. 178. The Su-27 has not, to date, been assigned a naval mission.

force, reduced further by the usual difficulties concerning maintenance, to cover Chinese ground and naval forces in the Spratly Islands."[24] Furthermore, even if China should acquire additional Flankers and succeed in mass producing some future Russian-designed fighter aircraft, the PLAN would still have problems providing adequate air cover because it lacks the air-to-air refueling capability necessary for such missions. Although China is making efforts to acquire tankers and set up a refueling system, these "tanker aircraft would themselves be vulnerable to attack, while they were in transit over the open waters of the South China Sea, from long-legged aircraft."[25]

The PLAN also has deficiencies in the area of ASW. Most of the PLAN's weapons used in ASW (e.g., depth charges, rockets, and mortars) are upgrades of Soviet models of the 1940s and 1950s. The PLAN was still fitting the obsolete BMB-2 depth-charge mortar on its destroyers as late as the 1980s.[26]

Notwithstanding the PLAN's modernization efforts of the past 15 years, China's surface fleet is still antiquated. China's principal surface combatants—most of which were built in the 1970s and 1980s—were fitted with radars based on Soviet designs of the 1950s (see table 3 on pages 25 and 26). The Luda-class destroyer relies on the primitive P-band "Bean/Pea Sticks" radar (with multiple-dipole antenna) for air surveillance.[27] The Jiangwei frigate has an air surveillance radar based on the Soviet Knife Rest radar fitted on post-World War II Soviet cruisers. Table 3 also shows that other radars fitted in the PLAN's surface ships (e.g., Eye Shield, Square Tie, and Sun Visor) for the purposes of fire and missile control and target designation, respectively, are all derived from post-war Soviet radars. Reports in *Jane's Intelligence Review* also point out that "until recently, only passive ESM warning antennae (the Chinese Jug Pair radar) were fitted on

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24. Ibid.

25. Ibid.

26. Jordan, p. 277.

27. Jordan, pp. 276-7.

Chinese surface ships, and there was no integrated computer-based combat data system."[28]

Similarly, China's surface ships are armed with naval artillery based on obsolete Soviet designs. The twin 130-mm/58 mounted on the Luda-class destroyer, the single and twin 100-mm/56 mounted on the Jianghu frigate, and the twin 37-mm/63 found on almost all PLAN surface units are all based on 1930s' designs.

The PLAN also needs more replenishment and supply ships with greater range and carrying capacity. Joseph Morgan of the East-West Center writes that "the Chinese (Fuqing class) tankers displace only 7,500 tons (standard) and 21,750 tons (full load). Although [these ships] are capable of underway replenishment operations, their limited size and cargo capacity make them only marginally useful." [29] In comparison, most U.S. oilers displace 40,000 to 50,000 tons fully loaded.[30]

China's inventory of numerous diesel-powered attack submarines, five nuclear attack submarines, and one nuclear ballistic missile submarine looks impressive (see table 1). However, a number of factors reduce the effectiveness of China's submarine force.

First, with a few exceptions (the Han-class submarines have French-made Du-ux 5 sonar), Chinese sonar installed in many of its submarines are derived from Soviet designs of the 1950s (e.g., the Hercules, Feniks, and Shark Teeth sonars).

Second, a number of analysts have called into question the operational readiness of China's submarine fleet. An article in *Jane's Fighting Ships* observed that China's Romeo-class submarines spend only a few days at sea each year because there are too few trained sailors.[31] Thus,

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28. Ibid.

29. Joseph R. Morgan, *Porpoises Among the Whales: Small Navies in Asia and the Pacific,* the East-West Center, No. 2, March 1994, p. 35.

30. *Jane's Fighting Ships, 1995-6,* p. 835.

31. *Jane's Fighting Ships, 1994-5,* p. 116.

Chinese submariners who desperately need the training at sea are spending most of their time on shore.

Third, the *Asian Defence Journal* points out that Chinese submarine propellors are:

> ...cut to a lower level of precision, resulting in the onset of cavitation at even low speeds. Their (PLAN) machinery is noisy, and vibration dampening technology is in its infancy....In the case of the conventional powered boats, short battery life combined with the absence of air-independent propulsion means frequent snorkelling. Given the noisiness of PLA naval machinery, [coming] up to breathe would be suicidal in the face of a modern enemy.[32]

China's Song-class attack submarine with its highly skewed seven-blade propellor and hydrodynamic hull for greater stealth may eventually prove troublesome to the navies of the region.[33] It remains to be seen, however, how effective the Song-class submarine is against modern ASW surveillance and detection capabilities, and how successful China will be in either producing large numbers of this class or retrofitting its new propellor on older craft.

As to the possibility that China will buy an aircraft carrier from some outside source, it lacks the C^4I, electronic countermeasures, maintenance and repair personnel, and trained pilots[34] to conduct effective

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32. Ryan, p. 31.

33. Barbara Starr, "Designed in China: A New SSK is Launched," in *Jane's Defence Weekly,* 13 August 1994, p. 3.

34. The Chinese are attempting to remedy this situation, however. Carrier-based aircrews are allegedly being trained at a naval base in northern China and at Guangzhou Naval Academy. Pilots have been trained to land and take off of a full-scale, land-based mock-up of a carrier deck about the size of HMAS *Melbourne.* The instructors are Russian and Chinese technicians. For more information, see *Periscope Chinese Navy/ Marines Data Base* by United Communications Group in cooperation with the U.S. Naval Institute, July 1995.

carrier operations at present and in the foreseeable future. It should also be noted that the Russian Navy took over 20 years to build, train personnel, and develop the doctrine for effective carrier operations.[35] Similarly, despite the purchase of the Vikrant aircraft carrier from Great Britain in the 1960s, India took about 20 years to develop its naval air arm into one that could meet naval demands beyond that of coastal defense.[36] In short, China faces a number of years before it can effectively operate and maintain an aircraft carrier.

Future Chinese navy requirements

For the PLAN to become a modern force comparable to its potential regional adversaries[37] and capable of undertaking those missions most important to its strategic objectives, it would need to develop or acquire adequate ship defenses for its surface fleet. This means:

- Installing surface-to-air missiles on its destroyers and frigates with greater range than the French Crotale missile that could target and bring down long-legged antiship missiles.
- Acquiring or building enough advanced fighter aircraft to establish air superiority over the Spratly Islands and at least the waters around Taiwan. This also means that the PLAN and the PLAAF must have enough fighters to engage the types of aircraft now being acquired by China's Southeast Asian neighbors and by Taiwan.

35. See Paul Pierce, "Aircraft Carriers and Large Surface Combatants" in Bruce Watson and Susan Watson, eds., *The Soviet Navy: Strengths and Liabilities,* Westview Press, Boulder, Co., 1986, pp. 73-4; and Norman Polmar, *Guide to the Soviet Navy,* Naval Institute Press, Annapolis, Md., 1983, pp. 75-6. Also see John Downing, "The Status of the Russian Navy" in *Jane's Intelligence Review,* June 1995, pp. 244-5.

36. Ashley J. Tellis, "Securing the Barrack: The Logic, Structure and Objectives of India's Naval Expansion" in *Naval War College Review,* Summer 1990, pp. 91-3.

37. For purposes of this analysis we assume China's potential adversaries are Japan, Taiwan, and a united ASEAN (Association of Southeast Asian Nations), including Vietnam.

- Providing fighter protection for China's air-to-air refueling tankers.

In addition to the pre-condition of developing ship defenses for China's fleets, the Chinese will have to do the following to develop an effective regional navy. *First,* they must increase the size of their surface forces and modernize them with modern fire control, radar, naval artillery, and surface-to- surface missiles, electronic countermeasures, and command and control. *Second,* China's regional power-projection capabilities would be greatly improved were it to procure and learn to operate an aircraft carrier. *Third,* China must expand the size of, and enhance the stealth and tactical capabilities of, its attack (diesel and nuclear) submarine fleet. *Finally,* China needs more logistics supply ships with greater range and carrying capacity.

Were the Chinese navy to acquire these capabilities, it could probably: (1) effectively enforce a blockade of Taiwan, and (2) sustain a naval force in the South China Sea for a prolonged period of time. (The second capability would include maintaining air cover for a PLAN and PLA Marine task force, meeting foreign opposition in Chinese naval operations in the South China Sea, and supplying Chinese naval vessels supporting a seizure operation in the Spratlys.) The reader should note that such a navy should be characterized as a "green water" or regional navy. That is, it would be capable of operating beyond China's coasts, achieving some limited (but important) strategic objectives, and damaging an intervening foreign navy.

For the Chinese navy to be considered "blue-water capable," the PLAN would have to be able to seriously contest control over the seas adjacent to the Chinese coast (the South China Sea and the East China Sea) as well as threaten to deny those sea lanes giving other navies access to mainland China (Sea of Japan, Philippine Sea, and part of the North Pacific Ocean) against any other navy, excluding the USN.

Because we assume that the strategic objectives of the Chinese leadership are to develop a regional navy and to achieve its current strategic goals (e.g., Taiwan or Spratly contingencies mentioned above), we must focus on the question: Can China obtain a regional navy by 2010? But, from an analytic and policy perspective, whether China can develop a blue-water navy by 2010 also remains an important

question. In addressing the issue of China's future ability to field a regional navy, we also address, where relevant, whether China can obtain a blue-water navy.

China's neighbors

The regional PLA Navy missions discussed above will be increasingly difficult to accomplish over a 15-year time span, because by 2010 the rest of Asia will have grown economically and militarily as well. Southeast Asian GDP as a whole grew some 6.5 percent in 1993 and 7.1 percent in 1994.[38] Judging from economic analyses, there is also reason to believe that the economies of the region will continue to grow and that the modernization and expansion of naval and military capabilities will follow.[39] Bearing this in mind, it is possible to imagine an Asia-Pacific Region in 2010 characterized by a Japanese Maritime Self-Defense Force comprising several Aegis cruiser equivalents, a Republic of China Air Force made up of several hundred F-16s, a unified Korea with a more robust naval capability, and the proliferation of antiship cruise missiles and modern diesel submarines throughout the APR.

38. *U.S. Pacific Command Asia-Pacific Economic Update*, Spring 1994, p. 7.

39. Erland Heginbotham, *Asian Economic Prospects and Challenges*, CRM 95-229, Center for Naval Analyses, Alexandria, VA, March 1996.

Can China build a regional navy by 2010?

Statistics illustrate the rapid growth of China's economy over the past 15 years. The Chinese economy (real GNP) has grown an average of 9 percent since 1979.[40] By 1994 China's economy was four times the size of its economy in 1978. *The Economist* projects that by 2002 China's economy will be eight times bigger than in 1978.[41] The growth and strength of the Chinese economy is also illustrated by China's trade figures. In 1978, the year Chinese economic reforms began, China's level of trade was around U.S. $21 billion. By 1991, China's trade had reached U.S. $135 billion and by 1992 had grown to U.S. $170 billion[42]—making China the 11th largest trader in the world.

The remarkable growth in China's economy is also evident in its maritime-related industries. Since 1980, Chinese industry has recorded an impressive growth in the number of Chinese-produced ships of over 10,000 deadweight tons.[43] This development caught the attention of several authors, who warned of the military and strategic impact of the growth of China's shipbuilding industry since the early 1980s.[44] Undoubtedly, China's industry is capable of mass producing ships.

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40. See Lt. Col. John Caldwell, "Not Worth the Price" in *Armed Forces Journal International*, Feb. 1994, p. 20. Also see "China: the Titan Stirs," in *The Economist*, November 28, 1992.

41. "China: the Titan Stirs," in *The Economist*, November 28, 1992.

42. Ibid.

43. *Lloyd's Maritime Directory 1995*, Lloyd's of London Press, Ltd., Colchester, United Kingdom, 1995, pp. 28-48.

44. For example, see David Muller, *China As a Maritime Power*, (Annapolis: Naval Institute Press, 1983). Also see Swanson.

Constraints on indigenous production in China

China's defense industry record

As mentioned above, it is not the number of hulls in China's navy that could make it blue-water capable, but the technologies associated with that navy. For more than four decades, Chinese industry has not done well in locally producing surface ships, submarines, and aircraft with modern sensors, weapon systems, and command-and-control sytems. Table 3 shows that despite more than four decades of defense production, the platforms, radar, and weapon systems of China's locally produced naval and air forces are *still* based on the designs of those of three to four decades ago.

China's inability to produce a regional fleet locally is also illustrated by its shipbuilding record. China's locally produced Jianghu-Class frigate sold to Thailand has "reportedly been a disappointment, casting doubt on the competence of the PLA surface warship construction techniques."[45] The Luhu-class DD, the PLAN's most modern, locally produced combatant was assessed by *Jane's Intelligence Review* as "less sophisticated (or capable) than the 30 year old US Navy's Farragut (DLG-6) class of comparable tonnage."[46]

China's educated and technical talent pool

In the next 10 to 15 years, China is not likely to be able to develop and mass produce advanced naval systems. It lacks the engineering and technological expertise to do so. Some World Bank reports point out that "in comparison with other developing countries, the number of people in China with post-secondary education—only about 0.5 % of the adult population —is very small."[47] The actual number is not small—0.5 percent of 900 million adults is 4.5 million;[48] however,

45. Ryan, p. 31.

46. Gordon Jacobs, "Chinese Naval Developments Post-Gulf War" in *Jane's Intelligence Review*, February 1993, p. 83.

47. *China: Management and Finance of Higher Education*, World Bank Study, Report No. JLC068164, 1986, p. 4.

48. China's total population is 1.2 billion people. Of that number, 900 million are adults.

Table 3. Chinese indigenously produced platforms and systems

Platform type & class	Name and type of installed system	Approximate decade of design	Original modelled after
Attack aircraft, F-6	---	1950s	MiG-19
Attack aircraft, F-7	---	1950s	Mig-21
Medium bomber, H-6 or B-6	---	1950s	Tu-16 Badger
Attack a/c Qiangjiji or Fantan		1950s & 1960s	
Fighter, Jian-7		1950s &1960s	MiG-21F-13
Transport a/c Yun-8		1960s	Antonov-An-12
Fighter, Jianji-8		1960s	
Maritime Bomber, Shuishang Hongjaji-5		1970s	
Transport a/c, Yun-7		1970s	Antonov-An-24
Fighter/bomber Jianiji Hong Zhaji-7		1970s	Soviet Su-24 "Fencer"
Light bomber, H-5 or B-5		1940s	Soviet Il-28
Attack submarine, Ming class		1950s	
Attack submarine, Han class		1950s equivalent	
DD, Luda	Surveillance radar	1950s	
DD, All	ASW mortars, rocket launchers	1940s & 1950s	
FF, Jiangwei	Air surveillance radar	1940s & 1950s	
Major combatants DDs, FFG	RBU120 close-in ASW weapon system	1950s	
Major surface combatants	Wokwon, fire control radar	1950s	Sunvisor, installed on Kotlin-class DDs
Attack submarines	Snoop Plate/Snoop Tray undersea surveillance radar	1950s	
Frigate, Jianghu	100mm naval gun	1930s	Post-war Soviet cruisers
DD, Luda	130mm gun	1960s	
Surface combatant	37mm gun	1940s	
SSBN, SSN. Golf, Xia, Han, Romeo, & Ming classes	Type 53 torpedo	1940s & 1950s	
DD& FF-Luhu, Luda & Jianghu	A244 ASW torpedo	1970s	
FF, Jianghu	Eye-Shield, air/surface radar warning system	1950s	
Surface combatants, mostly DDs	Square Tie target acquisition radar	1950s	Direct copy of Russian Osa-class radar
Surface combatants, Jiangwei FF	Knife Rest	1950s	Direct copy of Russian Osa-class radar

Table 3. Chinese indigenously produced platforms and systems (continued)

Platform type & class	Name and type of installed system	Approximate decade of design	Original modelled after
DD	BMB-2 depth charge mortar	1950s	
Attack submarine. Romeo	Hercules sonar system	Post-war Soviet design (1950s)	
Attack submarine, Kilo type 827	Shark Teeth sonar	1970	

Source: *Jane's Fighting Ships, 1994-5; Jane's All the World's Aircraft, 1994-5; Jane's Radar/EW Systems, 93-4; Jane's Naval Weapon Systems*-Issue 15; *Jane's All the World's Aircraft, 1980-1; Jane's All the World's Aircraft, 1993-4;* and; *Jane's Intelligence Review,* June 1994.

given the large number of private and state enterprises, government organizations, and foreign corporations competing for educated Chinese personnel, 4,500,000 individuals is not that large a pool. The lack of educated, technically proficient individuals in China is illustrated by the lengths some corporations and offices will go to to lure away staff from competitors and other organizations in China.[49] Since the late 1970s, Chinese enrollment in higher education has hovered around 3 to 4 percent. This is in contrast to the percentage of adult enrollment in higher education for middle-income developing countries (12 percent), in East European non-market economies (about 20 percent), and in the industrialized market economies (about 37 percent).[50] Finally, it should be remembered that an entire generation of potential engineers, technicians, and other intellectual contributors to Chinese technological development were lost in the Anti-Rightist Campaign (1957), the Great Leap Forward (1958), and the Great Proletarian Cultural Revolution (1966–1976).[51]

49. See "Investment: the Fever Cools" (Focus: China Trade & Investment) in *Far Eastern Economic Review,* August 31, 1995, pp. 42-44.

50. *China: Management and Finance of Higher Education,* World Bank Study, Report No. JLC068164, 1986, p. 4.

51. Some of China's intellectuals and scientific elite managed to survive these turbulent times and to continue to work on technologically advanced projects. See John Lewis and Xue Litai, *China's Strategic Seapower: the Politics of Force Modernization in the Nuclear Age,* Stanford Univ. Press, Stanford, CA., 1994.

Unless China's educational authorities can rapidly expand the number of technically educated adults by the early decades of the 21st century, the demand for personnel trained in engineering will be intense, and Chinese universities, polytechnic institutes, and "TV colleges" might not be able to graduate enough of these kinds of individuals to meet the growing demands of private Chinese corporations, state-owned enterprises, government organizations such as the military, and foreign corporations.

Additional evidence

The fact that China is engaged in reverse engineering projects at all serves as additional evidence that China's industries are, at present, incapable of locally designing and producing the types of regional naval capability China needs to assert itself in the APR in the next century. For the purpose of modernizing its military, the Chinese leadership is normally reluctant to invest in foreign technology because it is too costly. Chinese plans to hire British firms to fit the Sea Dart area-defense system on its Luda-class destroyers were halted in 1983 because of the huge cost of the project.[52] China is not averse to buying foreign technology; it is only that the Chinese leadership has been reluctant to rush into importing foreign technology unless absolutely necessary.

Conclusions

We conclude that China cannot build a regional navy by 2010 without foreign participation or assistance.[53] The current platforms and weapon systems produced by the Chinese defense industry are decades behind those of the developed countries of the West. China lacks the educated citizenry, those with engineering or technical backgrounds necessary to build the infrastructure or design the specifications to produce a regional navy by 2010. It should also be noted that the shortage of educated and technically oriented individuals in

52. Jordan, p. 277.

53. "Without foreign participation" is defined as complete autarky. Under this definition, Chinese industry would be deprived of (1) the benefits of imports of foreign systems and technologies, and (2) access to foreign technicians and managerial techniques.

China was made worse by the loss of an entire generation of intellectuals during the Great Leap Forward and the Cultural Revolution of the 1950s and 1960s. Finally, the fact that the Chinese are buying advanced naval and air assets from the West and from Russia is an implicit admission that the Chinese cannot build these platforms without foreign participation.

Would China buy a regional navy?

If Chinese industry is incapable of locally producing a regional navy in the next 15 years, it is theoretically possible that China can buy itself a regional fleet. This involves paying for the unit cost of a weapon or platform times the number desired, plus some follow-on support. Chinese industry and the PLA then must deal with other obstacles, such as the lack of technical knowledge to maintain and operate these newly acquired assets.

The increasing cost of foreign weapon systems and platforms may outpace Chinese economic growth and could prove too costly for the PLA. If China were interested in buying a regionally oriented navy off the shelf, its ability to do so would depend on factors beyond the Beijing government's control—that is, the pace and extent of China's economic growth and the cost of foreign weapons and platforms over the next 15 years.

A Third World defense expenditure model

The Center for Naval Analyses undertook a study to address the issue of future economic performance of a notional Third World country as it relates to that country's ability to purchase naval and air assets. CNA's Economically Feasible Threat Model[54] projects the likely future defense budget of a typical Third World country and compares that budget (broken down by procurement of aircraft, ships, and weapons) to projected unit costs of specific types of platforms (e.g., ships and aircraft).

54. See Barry G. Pifer, *An Economically Feasible Threat Case Study: Predicting the Military Capabilities of a Third World Nation in 2020*, CRM 92-67, Center for Naval Analyses, February 1993.

As shown in detail in appendix A, the model considers a current defense budget for a Third World country, and assumes one of three different rates of growth for that country—8 percent, 4 percent, or no growth. Assuming that levels of defense expenditures are held at 5 percent of GDP (an assumption consistent with Third World historical data[55]), the model then extrapolates over the next 15 years (or whatever time period the analyst desires) the size of the country's projected defense budget. The model breaks down the extrapolated defense budget according to a budget distribution model based on historical data of the allocation of defense funds among Third World countries.

At this point, determining the affordability of specific weapon and platform systems for a given future date depends on the cost of these assets over time—in short, the effects of inflation on the costs of aircraft, ships, and weapon systems. The CNA model assumes a constant rate of inflation depending on the asset under scrutiny. It assumes a constant growth of 4 percent for surface ships and submarines, and a growth of 12 percent for aircraft.[56] These platform costs were assumed to be equivalent to those of similar U.S. ships and aircraft (refer to appendix A, table 13 for the assumed starting costs of these platforms). Having established a presumed rate of inflation, we can now approximate the affordability of aircraft, ships, or weapons to be purchased at some future date. Thus, we can project a historically based, notional, intended level of funds to be spent on procurement as a whole, on aircraft, and on ships under given economic conditions.

55. Ibid, p. B-2. The IISS' *Military Balance* shows an approximate 5 percent of GDP spent on defense for China, when GDP is calculated using the World Bank's Purchasing Power Parity (PPP) method. See *The Military Balance, 1994-5*(London, U.K: the International Institute for Strategic Studies, Brasseys, 1994), p. 170.

56. Pifer, pp. B-7, C-2 to C-4.

The Economically Feasible Threat Model applied to China

We took the model developed by analysts at CNA to examine the feasibility of the Third World threat by 2020 and applied it to China over the next 15 years. This required making a number of assumptions about China's level of defense expenditures and how it distributed overall defense procurement funds.

Some defense analysts estimate the percentage China spends on defense to be smaller than the 5 percent of GDP that CNA's model assumes Third World countries spend on defense. The official Chinese estimate of its proportion of GDP spent on defense is between 1.5 and 1.9 percent. *Jane's Defence Weekly* and a soon-to-be-published RAND study (which estimates China's defense budget at U.S. $140 billion[57]) claim that China spends about 3 percent of its GDP on defense.[58] Our model assumes China's defense expenditures as expressed in percent of GDP to be even higher than RAND's and *Jane's* 3 percent, to take into account the worst case of Chinese defense spending.

We then assumed that China spends about 30 percent on procurement, and of that amount 20 percent on ships and 30 percent on aircraft. This assumption is supported by the findings of other defense analysts looking at China. *Jane's Defence Weekly* claims that China spends 30 percent or less of its defense funds on procurement, and the recent RAND analysis of the PLA Air Force found that in 1992 China spent only about 20 to 25 percent of the PRC defense budget

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57. Curiously, if the RAND analysis is correct in saying that China spends roughly 3 percent of its GDP on defense, and it has a defense expenditure of U.S. $140 billion, then RAND must assume that China's GDP is roughly U.S. $4.7 trillion—the highest estimate given of China's economic strength. We do not agree that China's GDP is this high.

58. "Country Briefing: China" in *Jane's Defence Weekly*, 19 February 1994, p. 26; Barbara Opall, "Study Rings Alarm on PLA Budget" in *Defense News*, May 29-June 4, 1995, pp. 1, 37.

on weapons procurement.[59] Based on these assumptions, we projected what China would spend on procurement of naval assets up to the year 2010. When compared with projected costs of platforms, we arrive at different inventories depending on the level of Chinese economic growth.

Three future inventories for the Chinese Navy

After running CNA's modified model, in which we calculated what the Chinese could afford to buy given three assumptions of future Chinese economic performance (see appendix A for calculations), we arrived at three imported inventories for the PLAN.

Inventory one: the PLA Navy after 15 years of no growth

When China's economy was assumed to perform poorly (e.g., a growth rate of zero percent), the resultant inventory by 2010 of the PLAN's imported ships and submarines (see table 4) resembled that of a coastal navy, albeit one with the skeletal beginnings of a force that could venture beyond China's coasts.

Inventory two: the PLA Navy after 15 years of moderate growth

When China's economy was assumed to perform moderately well (e.g., a growth rate of 4 percent), the PLAN's imported naval force (see table 5) suggests a considerably more formidable navy. After 15 years, the Chinese navy could purchase two VSTOL aircraft carriers, a handful of Aegis cruiser equivalents, and a medium-size submarine, frigate, and destroyer fleet.

Inventory three: the PLA Navy after 15 years of high growth levels

Finally, when China's economy was assumed to grow at 8 percent per annum, the PLAN's imported force (see table 6) looked like a green-

59. "Country Briefing: China," *Jane's Defence Weekly*, 19 February 1994, p. 35; and Kenneth Allen, Glen Krumel, and Jonathan Pollack, *China's Air Force Enters the Twenty First Century*, (Santa Monica, CA: RAND, 1995), p. 138.

Table 4. Inventory 1: PLAN imported acquisitions assuming zero-percent economic growth, 1995 to 2010[a]

Platform	1995-2000	2000-2005	2005-2010	Total
Submarine	7	4	3	14
DDGs/Cruisers	2	3	2	7
Frigates	5	4	3	12
Aegis cruiser equivalents	1	1	0	2
VSTOL carrier	0	0	1	1
Auxiliary ships	3	2	2	7
MCM[b]	2	0	0	2
Total costs	\$13.6 bn	\$13.8 bn	\$13.9 bn	
(Total funds available)	\$14.4 bn	\$14.4 bn	\$14.4bn	

a. This analysis assumes 4-percent inflation for ships and the cost of these assets reflects U.S. prices.

b. This assumes that by 2010 China will have either developed or bought minehunting technology.

Table 5. Inventory 2: PLAN imported acquisitions assuming 4-percent economic growth, 1995 to 2010[a]

Platform	1995-2000	2000-2005	2005-2010	Total
Submarines	6	7	5	18
DDGs/Cruisers	4	2	4	10
Frigates	4	5	3	12
Aegis cruiser equivalents	1	3	1	5
VSTOL carrier	1	0	1	2
Auxiliary ships	2	2	3	7
MCM	2	2	3	7
Total costs	\$15.8 bn	\$19.1 bn	\$22.7 bn	
(Total funds available)	\$16.05 bn	\$19.46 bn	\$23.7 bn	

a. This analysis assumes 4-percent inflation for ships and the cost of these assets reflects U.S. prices.

water or regionally oriented navy. Note that even at 8-percent annual growth for 15 years, the PLAN would not be considered a blue water fleet as we have defined it. A navy consisting of two large-deck aircraft carriers, one VSTOL carrier, 26 submarines, 11 destroyers, 13 frigates, 9 Aegis cruiser equivalents,[60] and 12 auxiliary ships could not maintain control over the South China Sea and the East China Sea, much less do that and simultaneously deny access to the Sea of Japan, the Philippine Sea, and parts of the North Pacific Ocean.

Table 6. Inventory 3: PLAN imported acquisitions assuming 8-percent economic growth, 1995 to 2010[a]

Platform	1995-2000	2000-2005	2005-2010	Total
Submarines	7	10	9	26
DDGs/Cruisers	2	4	5	11
Frigates	4	6	3	13
Aegis cruiser equivalents	2	3	4	9
Large-deck carrier	1	0	1	2
VSTOL carrier	0	0	1	1
Auxiliary ships	4	4	4	12
MCM	2	2	4	8
Total costs	$17.7 bn	$26.2 bn	$38.9 bn	
(Total funds available)	$18.06 bn	$26.54 bn	$39.0 bn	

a. This analysis assumes 4-percent inflation for ships and the cost of these assets reflects U.S. prices.

60. The likelihood that China could purchase an Aegis cruiser equivalent is remote. It is unlikely that the United States would sell China Aegis technology, and, although Russia is willing to sell off its platforms and weapons in the aftermath of the Cold War, it lacks Aegis-type technology. We argue this point as part of an exercise to determine what China could afford to buy should such items prove available.

Caveats

This analysis reflects only a partial inventory of the PLAN. By 2010, China may still have some of its current naval force, albeit a quickly obsolescing one. This analysis also says nothing about the shore support, technological or technical manpower, logistical capabilities, training of PLAN officers, costs of missiles and ordnance, or other general measures of operational readiness. Also, because we have assumed that China spends 5 percent of its GDP on defense, instead of the 3 percent estimated by other analysts, the force structures generated from this analysis may be exaggerated to allow for the worst case.

Will China buy its regional naval capability?

Economic performance at high levels of growth (i.e., 8 percent) is not assured. China's economic growth could slow to 6 percent as suggested by some observers of China's economy.[61] It could also slow to 4-percent GDP growth or less. Nevertheless, even if China's economy continues to grow at high levels, the Chinese leadership will probably not pursue a strategy of buying its navy entirely from foreign countries for the following reasons:

- By purchasing a complete regional naval capability, China would not make the necessary investments for Chinese industry to reverse engineer and learn how to reproduce certain advanced products.
- In purchasing its regional navy off the shelf, China could be depriving itself of the technical/engineering assistance, production rights, and blueprints of the very military assets it would eventually want to produce on its own.
- By purchasing a complete regional navy, China risks placing its national security future in the hands of other countries, a mistake the Chinese leadership vowed it would never make again.
- Finally, the Chinese recognize that a full-scale effort to purchase regional naval capability by 2010 would be certain to

61. Heginbotham, op. cit., p. 35

increase the anxiety among its neighbors. China's leaders will probably prefer a more gradual build-up and modernization of its forces while they attempt to keep the region peaceful and stable for the sake of its own overall economic development.

Conclusions on China's ability to buy a regional navy

The People's Republic of China can buy the *inventory* for a green-water or regional navy by 2010 if economic conditions over the next 15 years permit—that is, if China's economy grows an average of 8-percent per year, and China chooses to make that investment in preference to other goals.[62] If China's economy stagnates at zero-percent growth, the research found that China can still purchase some advanced naval and air assets to perform brown-water operations. We found that if China's economy grows at 4 percent per year over the next 15 years, China should be able to acquire assets suitable for nascent green-water operations such as a partial blockade of Taiwan, some sea denial of the area around the Spratlys, and the defense of its fleet against attacks from regional navies and air forces.

Apart from the issue of affordability, however, we argue that the Chinese leadership is not likely to purchase its regional naval capability directly, because: (1) buying a navy off the shelf is inconsistent with the history of modern Chinese defense development; (2) the Chinese want the process of defense modernization to support economic and industrial modernization in general—buying a regional naval capability off the shelf does not help in this way; and (3) the Chinese resist becoming dependent on other countries for their force requirements.

We also conclude that even if Chinese economic growth remains high (e.g., 8 percent), China cannot purchase a blue-water fleet as we have defined it. China would still not have a navy that could simultaneously control the South China Sea and East China Sea and deny other navies access to the Sea of Japan, the Philippine Sea, and part of the North Pacific Ocean.

62. The author also assumes that by 2010, China will have a supplier for such sales—a debatable assumption.

Can China reverse engineer a regional navy by 2010?

If China cannot produce a regional naval force by 2010 without relying on foreign help and if it is unwilling or cannot afford to purchase a regional navy off the shelf, it might instead further develop its naval capabilities through reverse engineering.

Current Chinese military research and development practices suggest that China is doing that. Reverse engineering fits the past practices of over four decades of military research, development, and production. Since the beginning of the People's Republic of China, the People's Liberation Army has acquired limited numbers of foreign weapon systems, aircraft, and warships in an effort to copy these military assets for local production. In short, China appears intent on continuing to reverse engineer advanced weapon systems and platforms. The question is: Can China do so and then mass produce a regional navy by the year 2010?

Reverse engineering and timeliness

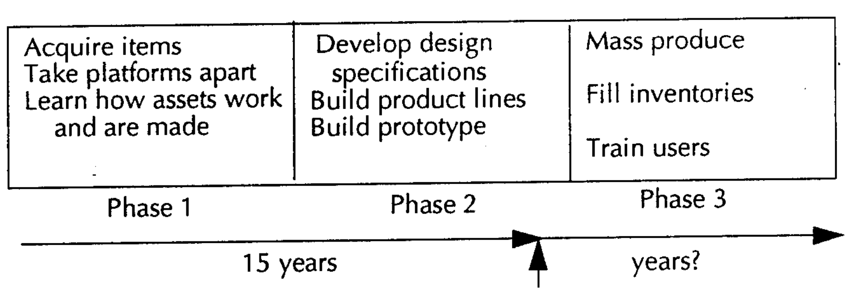
Examination of China's naval and air force inventories suggests that Chinese industry is slow at taking apart imported weapons and platforms, developing design specifications for the systems, and producing them in a series. As table 7 shows, the average time from acquisition of one or two model platforms to initiation of series production is about 15 years.

If we were to divide the reverse engineering process into discrete phases, it would look something like figure 1. Phase 1 involves the purchase of a small number of sample platforms or weapon systems from other countries to learn how these systems work. Phase 1, therefore, also involves operating them to determine how they work and taking these systems apart to determine how they are made. Phase 2

Table 7. Time line of Chinese reverse engineering projects (See appendix D for detailed sources of these data.)

Name	Capability	Date acquired	Date series production begins	Elapsed time (yr)
Jianjiji-8	Fighter aircraft	1964	1992	28
Yunshuji-8	Transport aircraft	1969	1986	17
Jianjiji-7	Fighter	1961	1979	18
Tu-16/H-6	Bomber	1957	1968	11
Zhi-8	Multirole helicopter	1976	Early 1990s	14-15
XJ-10	Fighter	1988	2008	Approximately 20
SD-1	Surface-to-surface missile	Early 1950s	Late 1960s	Approximately 15
C-101	SSM	Late 1970s	Mid – 1990s	Approximately 15
JL-1	SLBM	1967	1983	16
Z-9 Haitun (Dolphin)	Maritime surveillance helo	1980	1992	12
HY-1	SSM	1959	1974	15
Yunshuji-7	Transport aircraft	1975	1984	9
F-6/Mig -19	Fighter A/C	1958	1963	5
HQ-7	SAM	1978	1990	13

Figure 1. Chinese defense production time line, 1995–2010



involves the lengthy process of developing design specifications for the copied weapon or platform, constructing the equipment and physical plant to produce the indigenous model, and building that initial model or prototype. Finally, at the end of phase 2, the country is in the position to begin series production of that system. If history serves as a guide to the capabilities of China's defense industry, it takes China, on average, about 15 years to reach the end of phase 2. The amount of time China will require to field a usable regional navy will probably exceed the 15 years indicated here to reach series production, and it will take years longer to mass produce these platforms and fill the inventories for an operational fleet (phase 3 of figure 1). China will also require an unspecified amount of time to train the users (naval pilots, ship captains, sailors) of these naval assets and to develop the doctrine for the use of these assets.

Reverse engineering and cost

Even after discounting the overall costs to develop the design specifications, build the equipment and physical plant needed to produce prototypes and the production line, and test and evaluate the prototype, the question arises whether China could afford importing even a small number of systems to learn how they work. The Varyag carrier was offered to the Chinese for a cost of U.S. $2.4 billion; the Russian Kilo-class submarines cost the Chinese U.S. $1 billion. Taken in aggregate, these costs are not insignificant. The question arises: Can China afford the near-term investment even in the small number of platforms (phase 1) to be able to begin the reverse engineering process toward a regional naval inventory by 2010?

Consideration of weapon system or platform costs for the PLA immediately raises the issue of China's defense budgeting. There is no consensus on the actual size of China's defense budget, what China's defense budget includes in its calculations of defense expenditures, or whether inflation or the exchange rate has been adequately accounted for in calculating it. We do, however, have a range of predicted PRC defense budgets, models that represent approximate breakdowns of components of the Chinese defense budget, and approximate dollar figures of the cost of technologically advanced weapons or platforms (costed out at sellers' prices). From these we

can roughly determine the start-up costs to import a small number of technologically advanced ships and aircraft and other assets to learn how these systems work (phase 1 of figure 1), and compare these costs to presumed funds available for defense in China, in accordance with our model discussed in the previous section.[63]

China's defense budget

The official defense budget figure issued by China's Defense Ministry for FY 1994 was U.S. $7 billion. Recently, a number of analyses have pointed out that this defense figure is significantly understated.[64] The CIA argues that China's defense budget may be two to three times its publicly stated size.[65] That is, China's actual level of defense expenditures may range from U.S. $14 billion to $21 billion.[66] The CIA recognizes that the official Chinese figures account only for salaries, housing, operations and maintenance, portions of research and development, and weapons procurement.[67] Other analysts have included in their calculations such expenditures as allocations to defense-related industries, military research listed under the state science and technology budget, and earnings from PLA-run industrial and commercial enterprises. These calculations arrive at defense expenditure figures as high as U.S. $39 billion to $48 billion.[68] These numbers conform with analyses which argue that China's GDP may

63. Again, this is simply the cost to import the small number of platforms to learn how they operate and to learn how to rebuild them. This ignores the significant costs involved in developing design specifications, producing prototypes, building the equipment and physical plant needed for prototype and series production, testing and evaluating the platforms, and eventually mass producing the items.

64. Gary Klintworth, "China: Myth and Realities" in *Asia-Pacific Defense Reporter,* April-May 1994, p. 14; and Opall, pp. 1, 37.

65. Gary Klintworth, "China: Myth and Realities" in *Asia-Pacific Defense Reporter,* April-May 1994, p. 14.

66. Ibid.

67. Brahma Chellaney, "The Dragon's Rise: Implications of China's Military Buildup" in *Pacific Research,* May 1994, p. 10.

68. Ibid.

be as high as U.S. $1 trillion to $1.4 trillion if one uses the Purchasing Power Parity (PPP) method of calculating gross domestic product (as the World Bank does)[69] and our model's assumption that Third World countries spend roughly 5 percent of GDP on defense[70]—hence, 5 percent of $1 trillion = U.S. $50 billion.

A defense expenditure of roughly U.S. $50 billion for China also conforms with defense expenditure numbers published by the Arms Control and Disarmament Agency.[71] A U.S. $50 billion Chinese defense budget also roughly conforms with analyses that seek to determine the size of the total revenue base available to the PLA from commercial enterprises and other non-defense budget allocations.[72] Finally, one RAND study of Chinese domestic change and foreign policy indicated that China's defense expenditures could perhaps be "as much as six times higher"[73] than the official Chinese defense budget of U.S. $ 7 billion—thus, expenditures would be about U.S. $42 billion. The U.S. $50 billion estimate, however, does not conform with a report

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69. "China: the Titan Stirs" in *The Economist*, November 28, 1992.

70. Pifer, p. 8.

71. *World Military Expenditures and Arms Transfers, 1993-4,* U.S. Arms Control and Disarmament Agency, February 1995, p. 58. The defense expenditure figures provided by ACDA range from U.S. $53 billion in 1983 to U.S. $56 billion in 1993.

72. David Shambaugh has arrived at a figure of U.S. $45 billion in 1993. This included: $7.3 billion (Official Budget); $1.5 billion in arms sales; $14.3 billion in direct allocations to defense industries; $24.5 million in state subsidies for defense conversion; $5 billion in additional R&D investment; $3 billion for maintenance of the People's Armed Police and Special Forces; $2.5 billion in local contributions for regional force maintenance; $2.5 billion in regional unit PLA agricultural production and sideline production; $1.5 billion in militia maintenance; and $2 billion for pensions and demobilization costs. See David Shambaugh, "Wealth in Search of Power: The Chinese Military Budget and Revenue Base," paper presented at International Institute for Strategic Studies conference and in the conference report, *Chinese Economic Reform and the Impact on Security Policy,* July 1994, p. 32.

73. Michael D. Swain, *China: Domestic Change and Foreign Policy,* RAND Corporation, 1995, p. 76n.

published by RAND, which claims that China's defense budget could be as high as U.S. $140 billion.[74]

There is obviously no consensus on actual expenditure levels for the Chinese military. For our purpose, we take what appears to be a current majority opinion and assume that the Chinese are spending around U.S. $48 billion to U.S. $50 billion (seven times the official figures) on defense. This ensures (perhaps conservatively) that we have accounted for most of the Chinese government's defense-related costs without grossly exaggerating its defense expenditures.

Breakdown of Chinese defense expenditures

China watchers have long stated that most of China's defense expenditures go toward operations and maintenance—in particular, to the salaries of its personnel, retirement, and other manpower-related costs. This seems to make sense for a military that has traditionally been manpower-intensive and less dependent on new weapons and technologies. Despite the PLA's increasing emphasis on defense modernization and the acquisition of assets to wage modern war, retention of personnel (especially trained officers and technicians) and keeping the standard of living of its personnel above the levels of inflation remain two of the PLA's highest priorities.[75] In support of this perspective, *Jane's Defence Weekly,* in its survey of China, stated that half of China's defense expenditures are "believed to go on operating costs. Over 20 percent [are] ascribed to maintenance and training, and less than 30 percent for acquisitions."[76]

Using CNA's Economically Feasible Threat Model of a notional Third World distribution of procurement expenditures by service, platform (ships, aircraft, ground vehicles), and weapons, and applying it to China, appendix A shows the predicted distribution of Chinese expenditures on acquisitions. If we begin with a Chinese defense budget of U.S. $48 billion, we can expect about U.S. $7.78 billion per year

74. Opall, pp. 1, 37.

75. "Country Briefing: China," *Jane's Defence Weekly,* 19 February 1994, p. 35.

76. Ibid.

to be spent on weapon and platform acquisition alone (see appendix B).

Can China afford to buy the platforms/weapons to learn how they work?

If we assume that half of China's expenditures on acquisitions go toward purchasing the sample *foreign* weapons and platforms necessary for reverse engineering purposes, and half goes toward procuring assets produced in China, we arrive at the figure of U.S. $3.89 billion per annum dedicated to buying foreign military assets (Phase 1 of figure 1) for the purpose of reverse engineering. (See appendix B for calculations.)

Earlier we noted that China would need a range of new capabilities to be considered a regional naval force. To reverse engineer such capabilities, the PRC would still have to buy technologically advanced military platforms and weapons (phase 1 of figure 1) to be successful. These items are expensive and would represent a significant initial outlay for the Chinese government. Table 8 shows the type of expenditures Beijing would have to make if the PLAN is to reverse engineer the equipment for a regional navy by the year 2010. The PLAN would have a window of opportunity of about three years (1996–1998) if we assume that Chinese industry will require about 12 to 15 years to purchase a small number of sample systems, develop design specifications, and begin series production by 2010 (the end of phase 2 in figure 1). Hence, 1995 + 15 years or 1998 + 12 years = 2010, the target date of our examination of Chinese forces.

If the PLAN allocates about U.S. $4 billion per year to import advanced platforms and weapon systems, table 8 shows that it would have to spend in excess of this sum simply to have the few weapons and platforms with which to begin to understand how these systems work (phase 1 of figure 1). This shortfall is understated. This analysis does not include the cost to complete the reverse engineering process, i.e., the cost to research, redesign, and test these systems for local production; the production costs of prototypes(phase 2 of figure 1); the cost to train personnel in new, unfamiliar operations; or the cost

Table 8. Hypothetical PLAN blue-water shopping list and related costs, 1996 to 1998 (see appendix B for sources)

Year	Budget for procurement of foreign systems (adjusted for 4% growth in GDP)	Total cost of purchase (adjusted for 4% ship and 12% aircraft inflation)	Description of purchase (cost billions $ US adjusted for inflation)[a b]
1995	$3.9 billion	---	---
1996	$4.0 billion	$4.5 billion	2 Su-27s (0.15) 2 Kilo subs (0.52) 2AWACs equivalents (0.9) 2 Aegis equivalents (2.4) 2 MCM (0.5)
1997	$4.2 billion	$5.7 billion	1 carrier (2.6) Carrier refit (0.97) 2 E-2C equivalents (0.44) XJ-10 assist. (0.62) 2 UNREP (1.1)
1998	$4.3 billion	$6.7 billion	Ship modernization. (3.17) Gas turbine engine (2.8) J-8 upgrade (0.7)

a. The assets listed here as potential purchases for the Chinese navy are listed arbitrarily and are in no particular order for purchase.

b. We assume that in most cases China would need to purchase two of the weapon systems or platforms to begin the reverse engineering process—one for disassembly, the other for operational tests. We have relaxed this assumption for such high-price items as a Russian aircraft carrier.

to purchase these systems from Chinese companies once China's defense industry is able to mass produce them (phase 3 of figure 1).[77]

Also, recall that we have assumed that China's defense budget is about U.S. $48 billion. We have also estimated the amount China has dedicated to importing foreign platforms and weapon systems (around U.S. $4 billion). If China's defense expenditures are actually $16 billion, $21 billion, or $24 billion, as claimed by other projections, or if

77. This analysis does not arrive at overall conclusions about which way to arrive at a regional navy is most cost-efficient (building, buying or reverse engineering). Although purchasing samples of advanced systems, investing in physical plants and equipment, and training technicians for the reverse engineering process may cost more than buying a regional navy off the shelf, China would get returns from investing in infrastructure, employing workers, and training engineers. This type of analysis is left for future research projects.

China actually dedicates only U.S. $2 billion to $3 billion to import weapon systems or platforms, the gap between the start-up cost of importing these advanced systems and the PLA's allotted defense budget would be even larger.

There are, however, other estimates of what China spends to import special platforms and weapons for the purpose of research and development that support our findings. One unclassified source stated that in 1992 "The Central Military Commission (CMC) approved U.S. $2.8 billion in the...budget for procurement of advanced weapons from overseas. In addition, some 12 billion yuan were appropriated as an additional extraordinary budget for the crash program refurbishment and upgrading of existing weapons systems."[78] Other sources listed China as having a budget of roughly U.S. $2 billion to $3 billion for the import of such military assets as the Varyag aircraft carrier, Su-27 Flanker aircraft, MiG-31 Foxhound interceptors, and ASW helicopters. [79] Finally, one analysis of China's defense expenditures listed the amount China spends on military-related R&D, including the costs to import foreign weapons and platforms, as about U.S. $5 billion.[80] These sources suggest that China appears to spend between U.S. $2 billion to U.S. $5 billion on imported weapons and platforms for the purpose of modernization—roughly in the area of what we have calculated.

The evidence suggests that it would be difficult for China to reverse engineer the inventory for a regional navy by 2010. The average amount of time Chinese industry has required to begin series production of a platform or weapon system through a process of reverse engineering is 15 years. This means that if the Chinese begin the process of reverse engineering today, by 2010 they could begin series

78. *Defense & Foreign Affairs, Strategic Policy*, April 1992, pp. 8-10.

79. Edmond Dantes, "An Indepth Look at the Asia-Pacific Air Force and Future Procurement," *Asian Defence Journal*, January 1993, p. 22.

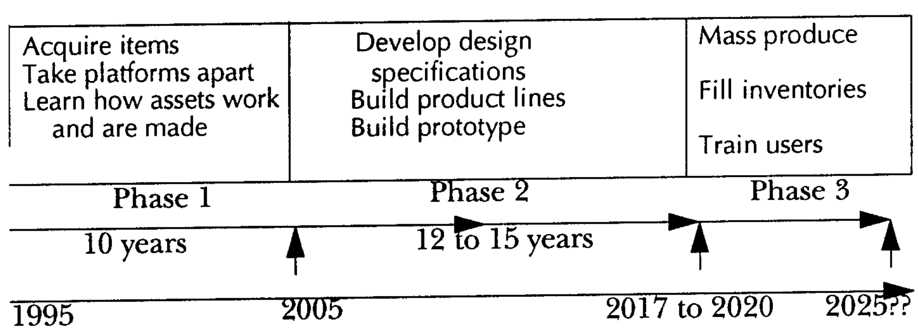
80. David Shambaugh, "Wealth in Search of Power: The Chinese Military Budget and Revenue Base." Paper presented at International Institute for Strategic Studies conference and in the conference report, *Chinese Economic Reform and the Impact on Security Policy*, July 1994, p. 32.

production of a number of naval and air assets for a regional navy. However, China will not have a full inventory by that time. Furthermore, if history serves as a guide, China would have to buy all the sample platforms and weapon systems it needs to begin the reverse engineering process in a very short period of time (1995 to 1998) if they plan to begin series production of these assets by 2010. As the research shows, these platforms are expensive, and, even when purchased in small numbers, they exceed what the Chinese are willing to pay.

Reverse engineering a Chinese Navy beyond 2010

On the other hand, the Chinese could stretch out the time required to reverse engineer a regional navy to about 2020. By purchasing naval assets from 1995 to 2005 (phase 1 of figure 2), they would be in a better position to develop design specifications, produce prototypes, build the equipment and physical plants, test and evaluate the prototype, train the technicians to produce the prototype and the eventual platform, and train those in the PLAN meant to use the naval asset (phases 2 and 3 of figure 2).

Figure 2. Chinese defense production time line, 1995–2025



Chinese efforts to reverse engineer and then produce the elements of a regional navy by 2020 or beyond are more affordable than the goal of a regional navy by 2010. As noted, China's defense industry was

shown to take, on average, 15 years to begin series production of advanced systems and platforms through reverse engineering. In a scenario in which the Chinese military was targeting 2020 as the date to produce a regionally oriented navy, China would have until 2005 (the end of phase 1 in figure 2) to procure sample assets and begin the process. Table 9 illustrates the "regional navy type" purchases and their cost to the PLA assuming a purchasing window of between 1995 and 2005. The table shows that the PRC can afford to buy the small number of regional naval assets needed when the purchasing period is spaced over a longer period of time.

Table 9. Hypothetical PLAN shopping list and related costs, 1996 to 2005 (see appendix B for sources)

Year	Procurement budget for imports (adjusted to 4% growth in GDP)	Total cost of purchase (adjusted for inflation--12% aircraft; 4% ships and weapons)	Description of purchase[a] [b]
1995	$3.9 billion	---	---
1996	$4.0 billion	$0.52 billion	2 Kilo subs
1997	$4.2 billion	$0.7 billion	2 Su-27s, 2 MCM
1998	$4.3 billion	$2.5 billion	Gas turbine engine--cruise missile application
1999	$4.5 billion	$3.5 billion	1 aircraft carrier + XJ-10 technical assistance
2000	$4.7 billion	$0.98 billion	1 aircraft carrier retrofit assistance
2001	$4.8 billion	$1.6 billion	2 AWACs
2002	$5.1 billion	$2.38 billion	2 Aegis equivalents
2003	$5.3 billion	$3.85 billion	Comprehensive ship modernization
2004	$5.4 billion	$0.97 billion	2 E-2Cs
2005	$5.6 billion	$1.2 billion	2 auxiliary ships/UNREP
Totals	$47.9 billion	$18.2 billion	

a. The assets listed here as potential purchases for the Chinese Navy are listed arbitrarily and are in no particular order for purchase.

b. We assume that in most cases China would need to purchase two of the weapon systems or platforms to begin the reverse engineering process. One for disassembly, the other for operational tests. We have relaxed this assumption for such high price items as a Russian aircraft carrier.

At the same time, China could use surplus funds saved from stretching the reverse engineering process over a longer period (see total procurement and total costs in table 9), to purchase a small number of platforms and weapons for immediate use in providing defense for China.

Is China hurrying to reverse engineer a regional navy by 2010?

The available evidence of Chinese defense modernization suggests that China is not rushing to reverse engineer a regional naval force by the year 2010. For China to be in a position to begin series production by 2010, it needs to import a small number of technologically advanced naval assets today. China should be pursuing an extremely aggressive import strategy. Instead, it is purchasing items piecemeal. A purchase of Su-27s one year is followed by the purchase of Kilo-class submarines the next year. China has also cancelled some reverse engineering and platform upgrade projects. China's cancellation of its British ship modernization program and the cancellation of its contract with a French aerospace firm to upgrade the avionics of the Chinese J-8 aircraft seem to contradict the idea that it is in a hurry to reverse engineer and upgrade its naval capabilities by 2010 regardless of the cost. In short, China appears to be taking its time.

Finally, China's defense industry and economy do not appear to have shifted gears for the purpose of large-scale reverse engineering and production of advanced weapons and platforms by 2010. The Chinese defense industry is significantly involved in the production of civilian goods. There is no evidence to suggest that Chinese defense industries are shifting back toward only military production. China's objective appears to be to buy time to develop the PRC's economy and armed forces.

Conclusions

Building a regional navy by 2010

We conclude that China cannot build a regional naval capability by the year 2010 without foreign assistance. We base our conclusions on the following observations:

- The Chinese defense industry currently produces weapon systems, aircraft, ships, radar, electronic equipment, and other military-related goods that are decades behind those of the United States, the West, and other developed countries.
- To design, build, and maintain a regional navy by 2010, the Chinese navy would be competing with the private economy and other services for engineers and technicians. The current percentage of individuals enrolled in post-secondary education is small compared to other developing countries, the countries of Eastern Europe, and middle-income countries.
- China's willingness to purchase foreign weapon systems and platforms for the purpose of reverse engineering shows that the Chinese themselves recognize that their industry alone cannot produce a regionally capable military without some form of foreign involvement.

The effectiveness of a historical analysis of Chinese defense production is diminished somewhat by: (1) the fact that China went through a number of political movements that proved unusually disruptive to productive efficiency,(2) the fact that the Chinese economy today is more open and exposed to foreign technologies and managerial processes (including an increasing number of Russian engineers for hire) than in the heyday of Chinese Communism, and (3) the recent development of new, advanced, and adaptable military technologies (e.g., cruise missile technologies) within Asia itself. However, we

argue that examples of the Chinese defense industry's problems with weapon and platform development can be found after the so-called turbulent years of Chinese politics, and well into the period of Chinese economic reform. The development of the XJ-10 began in the 1980s, after Deng Xiaoping ascended to power and established a more stable political environment, but the XJ-10 is not expected to be mass produced until the first decade of the 21st century. For more details on this point, see appendix C

Buying a regional navy by 2010

China's ability to purchase a regional navy depends in great part on its future economic performance. Using a model developed at CNA, we concluded that:

- If China's economy grows an average of 8 percent per year to the year 2010, China can afford to purchase the inventory for a green-water fleet or a regionally oriented navy including several attack submarines, two large-deck aircraft carriers, one VSTOL carrier, Aegis cruiser equivalents (an unlikely prospect, as noted earlier), a sizable number of frigates and destroyers, and underway replenishment ships, assuming that China is willing to ascribe priority to this purpose.

- Even with continued high rates of growth for the Chinese economy (e.g., 8 percent), China cannot afford to buy a blue-water navy as we have defined it.

- If China's economy grows an average of 4 percent per year until the year 2010, China will find affordable two small VSTOL aircraft carriers; a number of Aegis cruiser equivalents (again, an unlikely prospect); a medium-size submarine, destroyer, and frigate fleet; and a small number of supply ships.

- Finally, if China's economy stagnates at zero-percent growth per year for the next 15 years, China can still purchase a small VSTOL carrier, but its navy would be characterized as a small, coastal type fleet composed of a small number of advanced ships and aircraft purchased from the West.

Aside from the issue of affordability, the Chinese leadership is not likely to pursue a defense modernization strategy of buying a navy off the shelf. We argue this point for the following reasons:

- Buying a regional navy from other countries places China's national security and military capability in the hands of those countries. After China's military humiliation by the Western powers in the 19th century and the difficulties it went through in modernizing its economy and military after the Sino-Soviet split, China's leaders are reluctant to depend on other countries to provide it entirely with its instruments of national security.
- Purchasing a regional navy off the shelf without technical assistance reduces the effectiveness of Chinese reverse engineering, and hence of China's ability to learn how to produce technologically advanced goods (military or civilian).
- Finally, purchasing advanced military weapons and platforms for the apparent purpose of developing a regionally oriented navy would cause alarm among China's neighbors. The Chinese leadership recognizes that China's interests will be better served if China builds up gradually, purchasing some military goods and reverse engineering others for mass production over the course of 20 or more years.

Reverse engineering a regional navy

China's most likely avenue of defense modernization is the process of reverse engineering a modern military. As the research shows, however, it is impractical for China to attempt to reverse engineer a regional navy by 2010. On the other hand, if the Chinese stretch the process over a longer time horizon, the goal of a regional navy by around 2020 is both doable and suits Chinese foreign policy purposes:

- Chinese industry takes an average of 15 years to reverse engineer imported weapons and platforms from the time of acquisition of sample systems to the initiation of series production. A quick but effective reverse engineering process would

be difficult for Chinese industry. Moreover, the initial cost to import even a small number of technologically advanced naval assets would be substantial. It would exceed the current estimates of China's allocated expenditures for procurement of foreign weapons and platforms.

- Over a longer period of time, however, China can afford to import the small number of sample naval assets necessary for this process. The Chinese defense industry historically has taken this long to import a system, take it apart and learn how it works, redesign it, and mass produce it.
- A gradual process of reverse engineering and defense modernization would keep China's neighbors calm and promote a stable, peaceful region in which China's overall economic modernization can occur without significant interruption. At the same time, China could use surplus funds saved from stretching the reverse engineering process over a longer period of time to purchase a small number of platforms and weapons for immediate use.

Implications of findings

We drew a number of policy-related implications from the findings of our analysis. The final report of this study discusses these implications in greater depth and detail, and in conjunction with other reports of the security environment of Asia circa 2010. The general implications for the U.S. Navy and for the U.S. military and government are as follows:

- Military and policy planning that assumes China's navy will dominate the region or represent a threat to U.S. forces in the APR by 2010 is premature.
- Defense planning projections that account for a regionally oriented Chinese navy by about 2020 are probably more accurate.
- Hedging for a future Chinese regional navy may be good long-term insurance, but sizing today's forces for an up-and-coming Chinese naval threat by 2010 would be premature.

- At the same time, under the most pessimistic planning scenario, the USN could posit that China would be willing to purchase its regional naval capability entirely from other countries. In this case, a continued 8-percent growth in Chinese GDP for 15 years could serve as an indicator that by 2010 China might be able to back up its strategic objectives in the APR with significant military force.

Appendix A: Pifer's methodology for calculating future defense budgets and costs of military assets[81]

Assumptions of model: (1) The Gross Domestic Product (GDP) grows by zero percent, 4 percent, or 8 percent, (2) Third World defense budgets are roughly 5 percent of GDP as a rule, (3) inflation for ships and submarines is roughly 4 percent, and (4) inflationary costs for aircraft are roughly 12 percent.

Step one: Calculate projected defense expenditures for the next ten years.

(1) GDP is assumed to represent economic growth. The model also assumed one of three growth rates for the country under study (8-percent, 4-percent, or zero-percent). The proportion of GDP allocated to the defense budget is based on a historic review of Third World defense spending. This case study assumed that the defense budget would be 5 percent of the GDP. Budget profiles over the next 15 years were constructed by compounding the initial year's assumed budget by the growth rate assumed over the time span of interest.

(2) To compound the initial defense budget, the model uses a multiplication factor formula [$y = (1 + x)^n$], where n is the number of years after the current year, x is the growth rate expressed as a decimal, and y is the multiplication factor for year n.

(3) Using World Bank calculations of China's GDP, we start with a current GDP of U.S. $950 billion to U.S. $1 trillion.

81. See Barry G. Pifer, *An Economically Feasible Threat Case Study: Predicting the Military Capabilities of a Third World Nation in 2020*, CNA Research Memorandum 92-67, February 1993.

(4) Using the multiplication factor formula mentioned above, we can now calculate the projected GDP and defense budget for China over the next 15 years, once we assume a GDP growth rate of either 8, 4, or zero percent. For the sake of illustration, we assume a 4-percent growth rate for China's GDP:

$y = (1 + 0.04)^1 = 1.04.$

To determine China's projected GDP one year after the current year, we multiply its estimated GDP by the multiplication factor (y), or U.S. \$950 billion x 1.04 = U.S. \$988 billion.

Remember, we have assumed that China spends about 5 percent of GDP on defense expenditures. Therefore, we arrive at 0.05 x 988 billion = \$49.4 billion as China's defense expenditures for the year 1996.

To determine China's projected GDP ten years after the current year, we multiply China's estimated GDP by the multiplication factor (y), or U.S. \$950 billion x $y = (1 + 0.04)^{10}$ or U.S. \$950 billion x 1.48 = \$1,406 billion or \$1.4 trillion.

Again, assuming China continues to spend about 5 percent of GDP on defense expenditures, we arrive at U.S. \$70.3 billion spent on defense in the year 2005.

Tables 10 through 12 show projected Chinese defense expenditures assuming growth rates of 4 percent, 8 percent, and zero percent, respectively.

Table 10. Five-year cumulative defense budgets 1995 to 2010 (4% growth, current GDP U.S. $950 to U.S. $1 trillion)

Year	Projected GDP	Projected defense expenditures ($ billion)
1995	950.0 bil	
1996	988.0 bil	49.40 bil
1997	1026.0 bil	51.30 bil
1998	1064.0 bil	53.20 bil
1999	1111.5 bil	55.60 bil
2000	1159.0 bil	57.95 bil
Total		267.45 bil
2001	1197.0 bil	59.80 bil
2002	1254.0 bil	62.70 bil
2003	1302.0 bil	65.10 bil
2004	1330.0 bil	66.50 bil
2005	1406.0 bil	70.30 bil
Total		324.40 bil
2006	1463.0 bil	73.10 bil
2007	1520.0 bil	76.00 bil
2008	1577.0 bil	78.80 bil
2009	1643.5 bil	82.20 bil
2010	1710.0 bil	85.50 bil
Total		395.60 bil

Table 11. Five-year cumulative defense budgets 1995 to 2010 (8% growth, current GDP U.S. $950 to U.S. $1 trillion)

Year	Projected GDP	Projected defense expenditures ($ billion)
1995	950.0 bil	
1996	1026.0 bil	51.3 bil
1997	1111.5 bil	55.6 bil
1998	1197.0 bil	59.8 bil
1999	1292.0 bil	64.6 bil
2000	1396.0 bil	69.8 bil
Total		301.1 bil
2001	1510.0 bil	75.5 bil
2002	1624.0 bil	81.2 bil
2003	1758.0 bil	87.9 bil
2004	1900.0 bil	95.0 bil
2005	2052.0 bil	102.6 bil
Total		442.2 bil
2006	2213.5 bil	110.7 bil
2007	2394.0 bil	119.7 bil
2008	2584.0 bil	129.2 bil
2009	2793.0 bil	139.6 bil
2010	3011.0 bil	150.6 bil
Total		649.8 bil

Table 12. Five-year cumulative defense budgets 1995 to 2010, (0% growth, current GDP U.S. $950 to U.S. $1 trillion)

Year	Projected GDP	Projected defense expenditures
1996	950 bil	47.5 bil
1997	950 bil	47.5 bil
1998	950 bil	47.5 bil
1999	950 bil	47.5 bil
2000	950 bil	47.5 bil
Total	5700 bil	240.0 bil
2001	950 bil	47.5 bil
2002	950 bil	47.5 bil
2003	950 bil	47.5 bil
2004	950 bil	47.5 bil
2005	950 bil	47.5 bil
Total	5700 bil	240.0 bil
2006	950 bil	47.5 bil
2007	950 bil	47.5 bil
2008	950 bil	47.5 bil
2009	950 bil	47.5 bil
2010	950 bil	47.5 bil
Total		240.0 bil

Step two: Calculate the total amount the Third World country has allocated for expenditures on ships, submarines, and other naval assets.

(1) Pifer's model, based on broad Third World defense-expenditure data, assumes that the breakdown of defense expenditures is as follows: operations and support (55%) and procurement (45%). Of the procurement budget: vehicles (15%), aircraft (30%), ships, submarines, and boats (20%), space and electronic warfare (SEW) (15%), and weapons (20%). Of the total procured for weapons, the model assumes the following breakdown: army (50%); air force (30%), and navy (20%).

(2) As mentioned earlier in this research memorandum, the People's Liberation Army probably spends much less than the original CNA model assumes on procurement of equipment and much more on operations and maintenance (O&M). *Jane's Defence Weekly* predicts that the PLA spends as much as 70 percent on O&M and as little as 30 percent on procurement. The breakdown for Chinese defense spending then is probably as follows: operations and maintenance, including pay, training, construction, health, and retirement (70%); procurement (30%). Of the total amount spent on procurement: vehicles (15%), aircraft (30%), ships, submarines, and boats (20%), SEW (15%), and weapons (20%). Of the total amount spent on weapons: army (50%), air force (30%), and navy (20%).

(3) If the total projected PLA defense expenditure for 1995 to 2000 is U.S. $267.45 billion, then for the years 1995 to 2000 the PLA will spend U.S. $16.05 billion or U.S. $267.45 billion x 0.30 (procurement percentage) x 0.20 (percentage allocated for ships) on ships, submarines, and boats. If the total projected PLA defense expenditure for 2000 to 2005 is U.S. $324.4 billion, then for the years 2000 to 2005, the PLA will spend U.S. $19.46 billion or $324.4 billion x 0.30 (percentage allocated for procurement) x 0.20 (percentage allocated for ships) on ships and submarines. If the total projected PLA defense expenditure for 2005 to 2010 is U.S. $395.6 billion, then for the years 2005 to 2010, the PLA will spend U.S. $23.7 billion or $395.6b x 0.30 (percentage allocated for procurement) x 0.20 (percentage allocated for ships) on ships and submarines.

(4) Similarly, if the growth of China's GDP continues at the high rate of 8 percent each year until 2010, clearly the PLA will have more funds with which to purchase PLA Navy assets. As calculated above, if China's economy grows an average of 8 percent from 1995 to 2010, its cumulative defense expenditures will be U.S. $301.1 billion for the years 1995 to 2000, U.S. $442.2 billion for the years 2000 to 2005, and U.S. $649.8 billion for the years 2005 to 2010. Using the distribution model referred to above, the PLA will spend U.S. $301.1 billion x 0.30 (percentage allocated for procurement) x 0.20 (percentage allocated for ships)= U.S. $18.07 billion on ships for the years 1995 to 2000. The PLA will spend U.S. $442.2 billion x 0.30 x 0.20 = U.S.$26.53 billion on ships and submarines for the years 2000 to 2005, and the PLA will spend $649.8 x 0.30 x 0.20 = 39.0 billion on ships and submarines for the years 2005 to 2010.

(5) Finally, if we assume that China's economy has slowed to zero-percent growth, we notice that the total amount of funds dedicated to the procurement of ships and submarines for the year 1995 to 2000 is $14.4 billion, because U.S. $240 billion x 0.30 (percentage allocated for procurement) x 0.20 (percentage allocated for ships)= $14.4 billion. Consequently, because the Chinese economy is assumed to have no growth until the year 2010, the total amount of U.S. $14.4 billion is allocated for the procurement of ships from 2000 to 2005, and from 2005 to 2010 as well.

Step three: Calculate the future costs of ships, aircraft, and other military assets.

(1) To calculate the future costs of ships, aircraft, weapons, and other military assets, Pifer's model lists the current (1990) costs of these assets (table 13.).

(2) Then, using a growth multiplication formula similar to the formula used to calculate the growth of a Third World country's defense expenditures over time, the model calculates the cost of specific military assets at some date in the future.

(3) In the case of ships, Pifer's model assumed an annual growth rate of 4 percent continuing over the span of three decades. In the case of

Table 13. "Ballpark" cost breakdown of naval assets [a]

Platform	Unit cost (M$ 1990)
Submarine (conventional)	300
Cruiser/DDG	800
Frigate	600
Corvette	200
Aegis cruiser	900
Large-deck aircraft carrier	2,000
VSTOL carrier	1,200
Auxiliaries	400
MCM	200

Sources: Frank Killelea, CDR, USN, *The Economically Feasible Threat,* CNA, CRM 91-124, March 1992; and Pifer.

a. Reviewers point out that, in some cases, China could find much cheaper suppliers. A VSTOL carrier from Western Europe, it is argued, could be purchased for roughly U.S. $400 million.

aircraft, historical data revealed that the annual growth rate of these military assets would more likely run in the 12-percent growth area. For example, if the cost of an attack submarine in 1990 was U.S. $300 million, the cost in 2000 will be U.S. $444 million, the cost in 2005 will be U.S. $540 million, and the cost in 2010 will be U.S. $ 660 million. This is so because, according to the multiplication growth formula for the inflationary costs of ships, $Y = (1 + x)^n$. Where x = the estimated growth rate (in %) annually of the military asset; n = the number of years after the current cost of the military assets listed, and Y = the multiplication growth factor. In accordance with this formula, in the year 2000, the multiplication growth factor will be $Y = (1 + 0.04)^{10} = 1.48$. In the year 2005, the multiplication growth factor will be $Y = (1 + 0.04)^{15} = 1.80$, and in the year 2010 the multiplication growth factor will be 2.2 or $Y = (1 + 0.04)^{20}$. If the 1990 price of an attack submarine is U.S. $300 million, then in the year 2000, the cost of that submarine will be U.S. $300 million x 1.48 = U.S. $444 million. The cost of that submarine in 2005 will be U.S. $300 million x 1.80 = U.S. $540 million. Finally, the cost of that submarine in 2010 will be $ 300 million x 2.2 = $ 660 million. See table 14 for the projected cost breakdowns for ships and aircraft to the year 2010.

Table 14. Projected unit cost ($ M) (reflects U.S. prices for these platforms)

Platform	1990 prices	2000	2005	2010
Conventional sub	300	444	540	660
Cruiser/DDG	800	1,184	1,440	1,760
Frigate	600	888	1,080	1,320
Corvette	200	296	360	440
Aegis cruiser	900	1,332	1,620	1,980
Large-deck aircraft carrier	2,000	2,960	3,600	4,400
VSTOL carrier	1,200	1,776	2,160	2,640
Auxiliary	400	592	720	880
MCM	200	296	360	440
Multiplication growth factor	x 1.0	x 1.48	x 1.80	x 2.2

Step four: Determine what the country can afford to buy.

(1) Once the analyst estimates the five-year cumulative defense budgets for the country in question and the projected cost for ships, submarines, etc. at a given time, it will be possible to calculate what that country can afford to buy off the shelf assuming certain economic conditions (zero-, 4-, or 8-percent growth).

(2) Before engaging in this exercise, however, the analyst must determine what basic missions the country in question hopes to accomplish. A country seeking to protect its shores and coasts will follow a purchasing strategy far different from one that is attempting to develop a regional naval force.

(3) In this case, we are attempting to determine whether China can buy a regional navy, so we can assume that China wants to purchase power projection naval assets (i.e., carriers), missile defense assets (i.e., Aegis-type ships), ASW assets (i.e., destroyers and cruisers), logistics and at-sea refueling capabilities (e.g., auxiliary ships), and fleet protection assets (e.g., submarines). Tables 15 through 17 show the cost affordability and order of battle for China given different economic conditions (zero-, 4- and 8-percent GDP growth).

Table 15. Affordability of naval assets, assuming 4-percent GDP growth 1995 to 2010 (reflects U.S. prices for these platforms)

Platform	1995-2000	2000-2005	2005-2010	Total
Conventional sub	(6) 2.70 bn	(7) 3.80 bn	(5) 3.30 bn	18
DDG/Cruiser	(4) 4.70 bn	(2) 2.90 bn	(4) 7.00 bn	10
Frigate	(4) 3.50 bn	(5) 5.40 bn	(3) 4.00 bn	12
Aegis cruiser	(1) 1.30 bn	(3) 4.90 bn	(1) 2.00 bn	5
VSTOL carrier	(1) 1.80 bn	(0)	(1) 2.60 bn	2
Auxiliary	(2) 1.20 bn	(2) 1.40 bn	(3) 2.60 bn	7
MCM	(2) 0.60 bn	(2) 0.70 bn	(3) 1.30 bn	7
Total	15.80 bn	19.10 bn	22.80 bn	
(Total funds available)	16.05 bn	19.46 bn	23.70 bn	

Table 16. Affordability of naval assets, assuming 8-percent GDP growth 1995 to 2010 (reflects U.S. prices for these platforms)

Platform	1995-2000	2000-2005	2005 -2010	Total
Conventional sub	(7) 3.10 bn	(10) 5.40 bn	(9) 5.90 bn	26
DDG/Cruiser	(2) 2.40 bn	(4) 5.80 bn	(5) 8.80 bn	11
Frigate	(4) 3.50 bn	(6) 6.50 bn	(3) 4.00 bn	13
Aegis cruiser	(2) 2.70 bn	(3) 4.90 bn	(4) 7.90 bn	9
Large-deck aircraft carrier	(1) 3.00 bn	(0)	(1) 4.40 bn	2
VSTOL carrier	(0)	(0)	(1) 2.60 bn	1
Auxiliary	(4) 2.40 bn	(4) 2.90 bn	(4) 3.50 bn	12
MCM	(2) 0.60 bn	(2) 0.70 bn	(4) 1.80 bn	8
Total	17.70 bn	26.20 bn	38.90 bn	
(Total funds available)	18.06 bn	26.54 bn	39.00 bn	

Table 17. Affordability of naval assets, assuming zero-percent GDP growth 1995 to 2010 (reflects U.S. prices for these platforms)

Platform	1995-2000	2000-2005	2005-2010	Total
Conventional sub	(7) 3.1 bn	(4) 2.2 bn	(3) 2.0 bn	14
DDG/Cruiser	(2) 2.4 bn	(3) 4.3 bn	(2) 3.5 bn	7
Frigate	(5) 4.4 bn	(4) 4.3 bn	(3) 4.0 bn	12
Aegis cruiser	(1) 1.3 bn	(1) 1.6 bn	(0)	2
Large-deck aircraft carrier	(0)	(0)	(0)	0
VSTOL carrier	(0)	(0)	(1) 2.6 bn	1
Auxiliary	(3) 1.8 bn	(2) 1.4 bn	(2) 1.8 bn	7
MCM	(2) 0.6 bn	(0)	(0)	2
Total	13.6 bn	13.8 bn	13.9 bn	
(Total funds available)	14.4 bn	14.4 bn	14.4 bn	

Appendix B: Calculating the cost and affordability of Chinese reverse engineering plans

Step one: Research the current and potential weapon and platform sales to the People's Republic of China. Table 18 shows Chinese purchases of foreign military systems, prices of military platforms and weapons under discussion, and successful sales of Western weapons and platforms to other countries.

Step two: Calculate the amount of funds allocated to PLA Navy to import platforms and weapons for the purpose of reverse engineering.[82]

(1) Assume a GDP of U.S. $950 billion to U.S. $1 trillion and a resultant defense budget of about U.S. $48 billion to U.S. $50 billion(or U.S. $1 trillion x 0.05 = U.S. $48 billion to U.S. $50 billion).

(2) Assume a growth in GDP of about 4 percent per annum. Using the multiplication growth factor formula, $y = (1 + x)^n$, where n = number of years after current year; x = estimated percentage of growth per annum (in decimal form); and y = the multiplication growth factor. We arrive at the following GDPs for the years 1995 to 1998: $950 billion, $988 billion, $1,026 billion, and $1,064 billion, respectively.

(3) China's defense share has been between 3 and 5 percent of GDP. Assuming that this historic trend continues, we arrive at the following numbers as possible defense expenditures between 1996 and 1998: U.S. $49.4 billion, $51.3 billion, $53.2 billion, respectively.

82. We assume that in most cases China would need to purchase two of the weapon systems or platforms to begin the reverse engineering process. One for disassembly, the other for operational tests. We have relaxed this assumption for high-price items such as a Russian aircraft carrier.

Table 18. Sources for estimated costs of current and potential foreign military sales to the PLA Navy

Platform or weapon system	Price (U.S. $ billions)	Source(s)
Varyag former Soviet aircraft carrier offered to China	2.4	*Asian Defense Journal*, November 1992, p. 43
France offers to retrofit carrier	0.9	*Jane's Defence Weekly*, 19 February, 1994, p. 28.
26 Su-27s with engineering and technical assistance sold to China	1.5	*Jane's Defence Weekly*, 19 February, 1994, p. 28
Development assistance for XJ-10 program	.500	*Jane's Defence Weekly*, 19 February, 1994, p. 28
4 Kilo-class Russian submarines with technical assistance sold to China	1.0	*Wall Street Journal*, 9 February, 1995, p. A10.
Taiwan enters agreement with U.S. to buy 3 E-2C Hawkeyes and 1 EW aircraft	.700	*Jane's Defence Weekly*, 22 January 1994, p. 24
French government announces willingness to sell Taiwan comprehensive ship modernization package, including combat systems, 100mm guns, missiles, and electronic warfare equipment	2.6	*Jane's Defence Weekly*, 22 January 1994, p. 25; *Asian Defence Journal*, July 1992, p. 86.
Beijing pulls out of deal with Grumman to modernize J-8	.550	*Asia-Pacific Defence Reporter*, August 1990, p. 25.
Japan will buy 4 AWACs from Boeing	1.6	*Asian Defence Journal*, January 1993, p. 168; *International Defense Review*, September 1994, p. 9.
U.S. agrees to sell China APSAT, ASIGSAT-2, Intel-SAT, VIIA, STARSAT, AFRIASTAR, and Dong Fang Hong II SAT	.650	*Asian Defence Journal*, October 1992, p. 14.
1 Aegis cruiser	0.9	F.R. Killelea, *The Third World Economically Feasible Threat*, CNA, CRM 91-124, p. 14.
Garrett Engine Co. (subsidiary of Allied Signal) deal to sell China gas-turbine engines	2.0	*The American Spectator*, March 1995, p. 32.
1 auxiliary ship (AOR)	0.4	B. Pifer, *An Economically Feasible Threat Case Study*, CNA, CRM 92-67, p. C-2
1 MCM ship	0.2	F.R. Killelea, *The Third World Economically Feasible Threat*, CRM 91-124, p. 14

(4) Using the budget distribution model cited in appendix A, whereby 30 percent of China's budget is expected to go to total procurement; 20 percent is dedicated to purchasing ships, submarines, and boats; 30 percent is dedicated to purchasing aircraft; and 4 percent is dedicated to purchasing naval weapons, we arrive at the amounts below dedicated to purchasing ships, submarines, and boats for the years 1995 to 1998:

(a) For 1995 with an expected defense budget of $48 billion:

- $48 billion x 0.3 (percentage allocated for procurement) = 14.4 billion
- $14.4 billion x 0.2 (percentage allocated for procurement of ships, submarines, boats) = 2.88 billion
- $14.4 billion x 0.3 (percentage allocated for procurement of aircraft) = 4.32 billion
- 14.4 x 0.2 (percentage allocated for procurement of weapons) x 0.2 (percentage of weapons procurement allocated to Navy) = 0.575 billion
- For FY 95 total allocated for procurement of ships, aircraft, and naval weapons = 2.88 billion + 4.32 billion + 0.576 billion = 7.78 billion
- Assuming that half of this budget is dedicated to procuring Chinese-produced ships, aircraft, and weapon systems, and half is dedicated to importing systems for the purpose of reverse engineering: U.S. $7.78 billion/2 = U.S. $3.89 billion

(b) For 1996, with an expected defense budget of U.S. $49.4 billion:

- U.S. $49.4 x 0.3 (percentage allocated for procurement) = 14.8 billion
- U.S. $14.8 billion x 0.2 (percentage allocated for procurement of ships, submarines, boats) = 2.96 billion
- U.S. $14.8 x 0.3 (percentage allocated for procurement of aircraft) = 4.44 billion

- U.S. $14.8 x 0.2 (percentage allocated for procurement of weapons for all services) x 0.2 (percentage of weapons procurement allocated to the navy)= U.S. $0.592 billion
- For FY 96 the total allocated for procurement of ships, aircraft, and naval weapons = U.S. $2.96 billion + U.S. $4.44 billion + U.S. $0.592 billion = U.S. $7.99 billion
- Assuming that half of this budget is dedicated to procuring Chinese-produced ships, aircraft, and weapon systems, and half is dedicated to importing systems for the purpose of reverse engineering: U.S. $7.99 billion/2 = U.S. $3.996 billion or U.S. $4.00 billion

(c) The same procedures are used to calculate the amount allocated for importing ships, aircraft, and naval weapons for the purpose of reverse engineering for the estimated defense budgets of FY1997 and 1998 (U.S. $51.3 billion and U.S. $53.2 billion).

Appendix C: Anticipated objections to analysis and other issues addressed

The following discussion highlights the author's assumptions and the possible objections to the analysis. Economists and other analysts at CNA[83] point out that both should be explicitly stated and discussed for a fuller understanding of the report.

(1) **China's acquisition of Hong Kong could boost China's intake of capital, hence increasing its ability to buy weapons and systems from abroad.** The acquisition of Hong Kong will also undoubtedly increase Beijing's access to individuals with management, production, and engineering know-how, thereby increasing its ability to reverse engineer and mass produce technologically advanced systems. However, we would caution that: (1) China has not successfully managed the Colony yet—Beijing could strangle the goose that lays the golden egg; (2) it remains to be seen, after 1997, whether the existence of other competing economies in Asia (especially Singapore) will reduce the economic benefits Beijing will derive from Hong Kong; and (3) the already large amounts of Hong Kong direct investments and the many Hong Kong and other overseas Chinese joint ventures in China (especially in Guangdong province) suggest that the Hong Kong factor has already assisted the booming Chinese economy. Future economic benefits after Hong Kong's return to China should not be exaggerated, since China has already accrued these benefits for some time now.

83. The author thanks Dr. John Noer, an economist at CNA, and Mr. Juma Thorpe, an analyst at CNA, for their helpful insights on the assumptions one makes when applying the Economically Feasible Threat methodology to an analysis of future Chinese naval forces.

(2) **China's ability to purchase weapons and military systems might be less a function of GDP, and more a function of successful exports of China's weapon systems of its own.** China's arms sales to various countries in the Middle East and South Asia have earned China a reputation as one of the Third World's leading arms exporters. These arms sales have undoubtedly contributed to China's ability to purchase weapons itself or to maintain its armed forces consisting of more than 3 million. However, the argument that China's arms sales to other countries will be an additional determinant of China's ability to arm itself is on shaky grounds. China's ability to earn hard currency from weapons exports has declined and continues to decline significantly. First, with the end of the Cold War many Western nations and Russia have experienced significantly declining defense budgets, and, hence, fewer funds have been allocated to defense contractors and munitions manufacturers since 1989. The result, states *Jane's Defence Weekly*, is that the availability to Third World arms consumers of U.S. and European weapons has increased, intensifying the competition for such Third World providers of weapons as China and India. Second, the demand for Chinese weapon and platform exports has fallen off since the end of the Iran–Iraq War. *Jane's Defence Weekly* points out that

> Chinese arms exports have plummeted tenfold from more than U.S. $1 billion annually in the late 1980s to around U.S. $100 million in 1992. The drop resulted mainly from a drastic scaling back in orders from the Middle East.[84]

Finally, defense analysts have pointed out that the funds allocated to the PLA after arms sales were modest even before the decline in sales to the Middle East. Gary Klintworth of the *Asia-Pacific Defence Reporter* claims that

> the total earned by China in arms sales over the period 1984–1991 was about U.S. $14.4 billion. Perhaps 30 percent of that was returned to the PLA. However, assuming that all of it went

84. "Making a Modern Industry: Country Briefing China" in *Jane's Defence Weekly*, 19 February 1994, p. 30. Also see Karl W. Eikenberry, *Explaining and Influencing Chinese Arms Transfers*, INSS, NDU, McNair Paper 36, February 1995, p. 11.

> to the PLA, it would mean an average addition to the defence budget over the period 1984-1991 of U.S. $1.8 billion per annum, a relatively modest sum.[85]

And this assumes that every yuan earned through arms sales goes back to the PLA—a questionable assumption.

(3) **China's involvement in the economic reform process must be seen as a process that will speed up the ability of the Chinese economy to procure weapons and platforms. In short, as China's economy develops, might not its acquisition and reverse engineering process also accelerate?** The Chinese have definitely made efforts in recent years to reform their weapon and platform procurement process. But, contrary to expectations, this process will probably not significantly diminish the amount of time it takes China's military to conduct research and development, develop systems, and mass produce assets for its forces. Since the beginning of China's efforts to import weapons from other countries and reverse engineer them for indigenous production, China has attempted to "take shortcuts" and bypass what modernized countries would consider routine procedures for the testing and evaluation of new weapons. The Chinese attempted to rush the production of their version of the Soviet T-62 battle tank without an extensive "debugging" period.[86] The result was a product that never reached the production line.[87] As a consequence of reform in the acquisition process, Beijing will probably take precautions to be just as thorough as Western countries are in the process of conducting R&D, testing and evaluating, and, eventually, producing platforms and weapon systems.

Observers of China who point out that China's acquisition process may be becoming more efficient as its economy becomes more efficient are probably correct. But this process will most likely be no more efficient than, say, the acquisition processes of the more

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85. Gary Klintworth, "China: Myth and Realities," in *Asia-Pacific Defence Reporter*, April-May 1994, p. 14.

86. Michael Gallagher, "China's Illusory Threat," in *International Security*, Vol. 19, No. 1, Summer 1994, p. 180.

87. Ibid.

developed countries of the world. It still takes the United States about 12 years to turn a good idea into hardware.[88] For example, the Mark 48 torpedo program was initiated in 1956 and production began in 1972—16 years from concept development to mass production.[89] Other defense analysts have argued that one can probably expect an "acquisition process for a complex weapon system requiring ten years from concept development through completion of initial production."[90] Furthermore,

> concept development is generally preceded by exploratory work intended to condition the basic technologies needed for producing weapons. A reasonable assumption for exploratory developments is five years.[91]

In short, even if we accept the idea that China's platform and weapon system acquisition process is becoming more efficient, we can safely say that it is probably not becoming more efficient than the U.S. or Western system of procuring military assets. Analysts say the developed countries take an average of 12 to 15 years(which is within the bounds of our assumptions of Chinese defense industrial efficiency).

(4) An implicit assumption of the Pifer model (see appendix A) is unit income elasticity. An "income-elastic good" is a "good on which people increase the share of their total income expended on the good as total income increases. An "income-inelastic good" is one where the budget fraction drops as income rises." Is defense an income-elastic good? A fundamental assumption of this analysis is that defense is an income- elastic good. Economic critics are correct in pointing out the dangers of this assumption. If we assume that the weapons demand is actually income inelastic and that, for example, for every 1 percent of GDP growth, demand for weapons increased by only 0.70 percent,

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88. Richard Compton-Hall, Cdr, RN (Ret.), "Watching the Rear-View Mirror," in *Submarine Review*, October 1994, p. 47.

89. Ibid.

90. Barry G. Pifer, *An Economically Feasible Threat Case Study: Predicting the Military Capabilities of a Third World Nation in 2020*, CNA Research Memorandum 92-67, February 1993.

91. Ibid.

then the extrapolated "constant proportion" baseline for defense purchases presented in the main body of this paper would be overestimated. Taking this analysis further, if defense is considered a "luxury" good or that for every 1 percent of GDP growth, demand for weapons actually increased by 1.2 percent, then our extrapolated "constant proportion" base line for future defense purchases would be underestimated.

These theoretical concerns about "income elasticity" and "income inelasticity" are intellectually and practically correct. In fact, the data show that Chinese government spending has been "income inelastic." Dr. Michael Swain points out in a RAND study that in the 1980s, "[Chinese] economic growth of almost 9 percent was accompanied by central government expenditures growing at about 3.5 percent." China's government has shown that the State does not see public welfare (including defense) as a normal good, whereas our analysis assumes the Chinese government does. However, this does not detract from the original purpose of our analysis, which was to address the perceived exaggerated claims associated with China's future military force. By assuming that China's defense spending was "income elastic" instead of "income inelastic," we have constructed a model that may portray the realistic worst case, and that defines the upper bound of Chinese military defense spending.

This theoretical discourse, however, will probably be rendered less relevant soon as far as the China defense spending is concerned. In response to the growing perception of China's military that defense acquisition and modernization are not getting a fair share of the wealth resulting from Chinese economic reforms, the 1994 Chinese National People's Congress recently proposed linking annual military outlays to growth in the economy and inflation by indexing. A delegation of the People's Liberation Army has lobbied hard for and may receive indexed increases of at least the inflation rate, and a year-on-year increase of 3.5 percent of Gross National Product.[92] In short, although it makes sense from an economic theory standpoint to question that the demand for defense would be "income elastic," at

92. *Jiefangjunbao,* 17 March 1994.

the same time it may soon be a practical reality that the Beijing leadership links the purchase of additional military assets with the available income of the country. In short, the Chinese political leadership may impose a situation in which defense is transformed from an "income inelastic good" to an "income elastic good."

(5) **China's weapon system acquisition potential may depend less on China's GDP than on its foreign exchange earnings. China's trade has grown significantly over the past few years and has transformed itself into a trading economy. In fact, China's foreign exchange earnings could remain considerable even if GDP growth slowed down and if trade continued at its current levels.** China's trade is a significant factor in assessing the health of China's economy. It is also true that China's foreign exchange earnings boost China's ability to purchase weapons or platforms from other countries. However, we would argue the following:

- Most net assessments of the military capabilities of states rely on percentage of GDP spent on defense, not on levels of trade or even percentage of GNP. This may be because economic benefits derived from trade can be abruptly cut off by trading partners viewing the target state with suspicion, but the domestic economic and productive capacity of the state is more or less a solid determinant of a nation's economic strength. In short, it is more the common practice to use GDP as an indicator of military capability than to use levels of trade.
- It is less and less clear that Beijing would be able, if willing, to dedicate a continuing flow of funds to purchase defense assets if China's economic growth has stagnated. Although there is general disagreement among China watchers over China's prospects for holding together as a state or disintegrating into several regions, most China watchers would agree that China's government faces a host of social and economic problems ranging from hundreds of millions of individuals migrating from the countryside to the cities, to mass unemployment, to the

erosion of arable land in China.[93] Furthermore, even if Beijing were willing to spend the funds on a defense build-up in the face of domestic economic stagnation, it is unclear that it would be able to do so if confronted by the provinces and municipalities experiencing the fastest growth (the coastal provinces and cities) and which have become more and more autonomous.

- Delegates at the National People's Congress have called for indexing defense spending to a given level of economic productivity; whether that will be GDP or GNP is still to be seen.[94]

(6) An assessment of China's future defense production development (e.g., indigenous defense production and reverse engineering) based on China's record in this activity suffers from one significant shortcoming—the next 15 to 20 years of China's economic and industrial development are not likely to be similar to the past 40 years of Chinese economic development. It is true that the Chinese political system is unlikely to experience another "Great Leap Forward" or another "Cultural Revolution." It is also true that the Chinese defense industry enjoys advantages today that it did not enjoy in the 1950s, 1960s, and 1970s, that is, an unprecedented level of technical and engineering assistance from Russia, and an unprecedented level of exposure of China's economy and population to foreign technologies and managerial processes. This being said, the disruptive effects of the "Cultural Revolution" and "the Great Leap Forward" on China's capacity to develop weapons and platforms should not be exaggerated. Lewis and Xue illustrate that despite the turbulence of the times, the Chinese Communist leadership continued to dedicate funds toward the development of the atomic bomb and toward the creation of an indigenously produced nuclear-powered submarine.

93. For more on the social, economic, and political obstacles confronting China's leadership, see Jack Goldstone, "The Coming Chinese Collapse" in *Foreign Policy*, Summer 1995, p. 36; also see Gerald Segal, "Tying China Into the International System," *Survival*, Summer 1995, p. 61.

94. *Jiefangjunbao*, 17 March 1994. Also see David Shambaugh, "Wealth in Search of Power: The Chinese Military Budget and Revenue Base," Paper presented at International Institute for Strategic Studies conference and in the conference report, *Chinese Economic Reform and the Impact on Security Policy*, July 1994, p.22.

Other observers of China have pointed out that despite the widespread disruption of the Cultural Revolution on almost all walks of Chinese life, the Strategic Rocket forces, and other highly sensitive organizations appeared to be protected by the Communist leadership.

Furthermore, this memorandum's history of China's defense production includes periods after the Cultural Revolution and the Great Leap Forward. In fact, the prolonged development and production cycle time for the XJ-10 (F-10) fighter, the Zhi-8 helicopter, the C-101 SSM, and the HQ-7 SAM all took place in the post-Mao, Dengist era of the Chinese economy and polity.

Appendix D: Sources and citations for Chinese reverse engineering efforts

(1) **Jianjiji-7 (Fighter Aircraft 7) or Jian-7:** *Jane's All the World's Aircraft, 1994-4*, p. 47: "Soviet licence to manufacture the MiG-21 F-13 and its R-11F-300 engine granted to Chinese government in 1961, when some pattern aircraft and CKD (component knocked down) kits delivered, but necessary technical documentation not completed; assembly of first J-7 using Chinese made components began early 1964; original plan in 1964-5 was for Chengdu and Guizhou factories to become main airframe/engine production centers for J-7, backed up by Shenyang until these were fully productive, but plans affected by onset of cultural revolution. Static testing completed November 1965; first flight of Shenyang built J-7, 17 January 1966; Chengdu production of J-7 I began June 1967; development of J-7 II began 1975, following first flight 30 December 1978 and production approval September 1979."

(2) **Zhishengji-8 (Verticle Take-Off Aircraft 8) or Zhi-8**: *Jane's All the World's Aircraft, 1994-5*, p. 50. "Design work begun 1976, but suspended from 1979 to mid-1984; initial flights of first prototype 11 December 1985, second prototype October 1987; domestic type approval awarded 8 April 1989; first Z-8 handed over to PLA Naval Air Force for service trials 5 August 1989."

(3) **F-6 (MiG-19)**: *China's Airforce Enters the 21st Century*, RAND 1995, p. 222. "The MiG-19 first flew in 1952 or 1953. It was provided to the PLAAF in 1958, along with air-to-air and surface-to-air missiles, to counter Nationalist high-altitude and high-performance jet reconnaissance of the Chinese Mainland. Production...was...initiated at Shenyang, with a Chinese-assembled MiG-19 flying in 1958, and the first F-6 flying in September 1959. The early 1958 to 1960 "Great Leap

Forward," the complex design of the MiG-19, and the Sino-Soviet split of 1961 caused successful series production to be delayed until 1963."

(4) **B-6/Tu-16**: *China's Airforce Enters the 21st Century,* RAND 1995, pp. 228-9. "In 1956, the USSR agreed to build a factory for medium bomber manufacturing in China and granted a production license for the Tu-16 in 1957. Prototype production began at Harbin and Xi'an in 1959. Prototype assembly, using Soviet components, was completed quickly, and the first aircraft flew in September 1959. A small number of aircraft were completed in the following years. Following the Sino-Soviet split, all production was transferred to Xi'an. In 1964, work was completed on modifications to allow the B-6 to drop nuclear weapons. A successful delivery was completed on May 14, 1965. The first Xi'an-manufactured aircraft flew in December 1968, and series production began the following year."

(5) **Yunshuji-8 (Transport Aircraft 8) or Yun-8**: *Jane's All the World's Aircraft, 1994-5,* p. 58. "Redesign, as Chinese development of Antonov An-12B, started at Xian March 1969; first flight of first prototype 25 December 1974, followed by second 29 December 1975; production go-ahead given January 1980; type approval of Y-8X awarded September 1984. First Y-8B delivered 1986."

(6) **Jianjiji-8 (Fighter Aircraft 8) or Jian-8 Finback**: *Jane's All the World's Aircraft, 1994-5,* p. 59. "Development started 1964; first flight of first two prototypes 5 July 1969; flight trials (but no other J-8 activity) permitted to continue during 1966-76 cultural revolution, totalling 663 hours in 1,025 flights by prototypes; initial production authorized July 1979; three prototypes of J-8I then built (one lost before flight testing); first flight 24 April 1981 by second aircraft; production go-ahead for this version given July 1985."

(7) **The Hai-Ying 1 (HY-1)**: *Jane's Naval Weapons-Issue 15, 1995.* "In 1959, the Soviet Union supplied China with examples of the SSN-2A 'Styx'...which China decided to manufacture under license at the Nanchang Aircraft Factory as the SY-1...Even before the Sy-1 entered service, the Nanchang Aircraft Factory proposed in December 1964, that an improved version exploiting Chinese technology be

developed. The Chinese Navy already possessed a requirement for a dedicated coast defense derivative and in early 1965 Liu Shaoqi, chairman of the People's Republic of China ordered development of the missile as Hy-1 (Haiying-1 or Sea Eagle). A design review was held at Beijing in April 1965...This scheme, which involved modifying the radar seeker, autopilot, rocket motor, and booster, was completed rapidly. The prototype Hy-1 systems were completed in 1966 but failed their flight tests during 1966 and 1967...In May 1972, three missiles were used for flight acceptance trials and all hit their targets, but it was not until 1974 that the design was accepted for volume production which began the following year."

(8) **Z-9 Haitun (Dolphin)**: *Jane's All the World's Aircraft*, 1994-5, p. 54. "License agreement (Aerospatiale/CATIC) signed 2 July 1980; first (French built) example made initial acceptance flight in China 6 February 1982; Chinese parts manufacture began 1986; initial agreed batch of 50, last of which delivered January 1992."

(9) **Yunshuji-7 (Transport Aircraft 7) or Yun-7**: *Jane's All the World's Aircraft, 1994-5*, p. 63. "Reverse engineering of Soviet 48/52 passenger Antonov An-24 began in the mid-1970s, three prototypes (first flight 25 December 1970) and two static test airframes being completed; Chinese C of A awarded 1980); pre-production Y-7 made public debut 17 April 1982, production starting later same year; initial Y-7 entered service early 1984."

(10) **Xi'An F-7 (Mikoyan MiG-21) or Fishbed**: *Jane's All the World's Aircraft 1980-1*, p. 35. "Design of this Chinese copy of the Mikoyan MiG-21 fighter was based initially on that of a number of Soviet built MiG-21Fs (Fishbed-Cs) delivered to China prior (1958?) to the political break in 1960. The difficult task of copying the airframe, the R-11 afterburning turbojet (built at Shenyang) and equipment was completed so quickly that the F-7 made its first flight in December 1964 and began to enter service with the Chinese Air Force of the PLA in 1965."

(11) **The Chinese SD-1 Missile**: *Jane's Intelligence Review*, June 1994, p. 277. "Derived from the land based HQ-61, it took some 20 years to

develop. Installation has been limited to two frigates of the Jiangdong class. The missile reached operational capability 10 years after the completion of the first ship."

(12) **The C101 Missile:** *Jane's Intelligence Review*, November 1992, pp. 512-513. "The development of the C-101 probably started in the late 1970s, and models of the missile have been shown at exhibitions since 1986...There have been several trial firings of the C-101 since 1989...it is estimated that the In-Service date will be 1995. The Chinese have offered the C-101 for export, but there have been no reports of actual production orders being placed."

(13) **XJ-10 Fighter:** *Jane's Defence Weekly*, 19 February 1994, p. 28: "[The XJ-10] incorporates advanced technology from abroad—i.e., Israel provided some of the technologies from its defunct Lavi fighter project...Design of the XJ-10 began in the late 1980s, [and] analysts believe that a prototype could be ready for trials within 2-3 years. The first production aircraft is unlikely to become operational before the end of the decade (e.g., 2000), and may take longer if teething problems prove serious." *China's Airforce Enters the Twenty First Century*, RAND, p. 155. " The Chengdu Aircraft Corporation is nearing completion of an initial prototype of the F-10 (XJ-10), incorporating design features analogous to some found in the F-16, while also utilizing technologies first developed in the Israeli Lavi. Current estimates project an initial flight test 'in the next year or two' and 'initial operating capability in 10 years'...It is the authors' view that the F-10, if produced at all, will not be deployed until at least the year 2002."

(15) **Ju-Lang 1 (JL-1):** *Jane's Strategic Weapons-Issue 15, 1995.* " The CSS-N-3 has Chinese designation Ju-Lang-1. The PRC started development of their first submarine launched ballistic missile in 1967, for use with the 'Xia' class of nuclear powered submarine. The CSS-N-3 is thought to use some CSS-2 (which is itself a derivative of Soviet SS-2 'sibling missiles') technology, but took a long time to develop due to the need to master the technologies associated with solid propellants...Test firings were carried out in 1982, reportedly from a submerged pontoon (30 April) near Huludao and later, on 12 October, from a 'Golf II' class trials submarine... (The JL-1) were ceremonially

paraded in Beijing in October 1984, and it is believed that they became operational in 1983..."

(16) **FM-80 or HQ-7:** *Jane's Strategic Weapons-Issue 17, 1995.* "Initial reports suggest that the FM-80 (is)...a reverse engineered vesion of the French Crotale system. [It is] believed to have been in development since 1978. [It was] designed as a self-propelled vehicle for a static or trailer mounted point defense SAM system, and is believed to have the Chinese designator Hang-Qi 7 (HQ-7). [It] is believed to have entered production for the Chinese People's Liberation Army in 1989, and entered service in 1991."

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